SCHOOL OF CIVIL ENGINEERING

JOINT HIGHWAY RESEARCH PROJECT

JHRP-74-7

ENGINEERING SOILS MAP OF DELAWARE COUNTY

D. G. Shurig

PURDUE UNIVERSITY
INDIANA STATE HIGHWAY COMMISSION

Final Report

ENGINEERING SOILS MAP OF DELAWARE COUNTY

TO: J. F. McLaughlin, Director
Joint Highway Research Project

May 1, 1974

Project: C-36-51B

FROM: H. L. Michael, Associate Director
Joint Highway Research Project

File: 1-5-2-55

The attached report, entitled "Engineering Soils Map of Delaware County, Indiana," completes a portion of the project concerned with development of county engineering soils maps of the State of Indiana. This is the 55th report in the series. The report was prepared by Professor D. G. Shurig, Joint Highway Research Project.

The soils mapping of Delaware County was performed primarily by using the soil survey map sheets published by the Soil Conservation Service, United States Department of Agriculture in the soil survey of Delaware County. Airphoto interpretation techniques were used to supplement the pedological data. The resulting engineering soils map is presented as a blackline print.

Respectfully submitted,

Harold L Michael

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Final Report

ENGINEERING SOILS MAP OF DELAWARE COUNTY

by

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Research Associate

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Project No.: C-36-51B

File No.: 1-5-2-55

Prepared as Part of an Investigation

Conducted by

Joint Highway Research Project
Engineering Experiment Station
Purdue University

in cooperation with the

Indiana State Highway Commission

Purdue University
West Lafayette, Indiana
May 1, 1974

ENGINEERING SOILS MAP
OF
DELAWARE COUNTY, INDIANA

INTRODUCTION

Development of an engineering soils map of Delaware County was the primary goal of this project. The map is appended to this report; the report supplements the engineering soils map information.

The detailed pedological soils maps published in the 1972 Soil Survey of Delaware County by the United States Department of Agriculture Soil Conservation Service in cooperation with Purdue University, Agricultural Experiment Station (5) were the single most important source of data used in the project. These agricultural soils map sheets, at a scale of 1:15,840, were assembled to form a mosaic map of Delaware County. Careful study of the soil series descriptions enabled the grouping of the series into appropriate land form and parent material categories. Preliminary land form and parent material boundaries were then delineated on the mosaic-map.

Routine airphoto interpretation techniques supplemented the pedological data. Aerial photographs were examined and the preliminary boundaries checked and modified, if necessary, to produce final land form and parent-material boundaries. The photographs were contact prints at an approximate scale of 1:20,000. Date of photography was 1941.

The final land form and parent material boundaries were graphically reduced to produce the engineering soils map (1 inch = 1 mile). Symbols were used to delineate the parent materials as grouped according to land form and origin. Textural symbols were superimposed to indicate the relative compositions of the parent materials.

The map also includes a set of soil profiles which indicate the general soil profiles of topographically high and low sites in the larger land form parent material areas - namely ridge and ground moraines and alluvial plains. Other land forms did not show enough profile variation between topographic highs and lows to warrant drawing the two separate profiles.

Each profile shows the general range in depth and texture of each soil horizon - the A-, B- and C-horizon - the latter being the parent material. The soil texture classification system used in the map profiles is that of the Indiana State Highway Commission (the ISHC soil classification system chart is shown on the map in the lower right hand corner). The ISHC system differs slightly from the USDA system so that the use of USDA textures have to be converted to ISHC textures - for example, a USDA classified loam could be a loam or clay loam under the ISHC system.

The soil profiles drawn on the side of the engineering soils map have been numbered. Areas on the soils map have corresponding numbers to indicate the soil profile for that particular area in the field.

In the text of the report pedological soil names have been provided for each parent material soil area shown on the map. In Appendix B quantitative engineering soil test data is provided for each pedological soil name. In Appendix C qualitative data as to soil problems and certain advantageous soil uses are provided according to pedological soil names.

DESCRIPTION OF AREA

GENERAL

Delaware County is located in east-central Indiana - see Figure 1. Muncie, the county seat, is 50 miles northeast of Indianapolis.

County dimensions are about 21 miles in the north-south direction and about 19 miles east-west. The total area is 398 square miles.

"Farming is the leading occupation in Delaware County, though many people are employed by industry and some of the workers commute to Anderson, Marion and Indianapolis. About half the farm income comes from the sale of field crops or special crops and half from the sale of livestock and livestock products. Corn, soybeans, wheat and hay are the dominant crops. Dairy and beef cattle, hogs, chickens, and turkeys are raised extensively." (5).

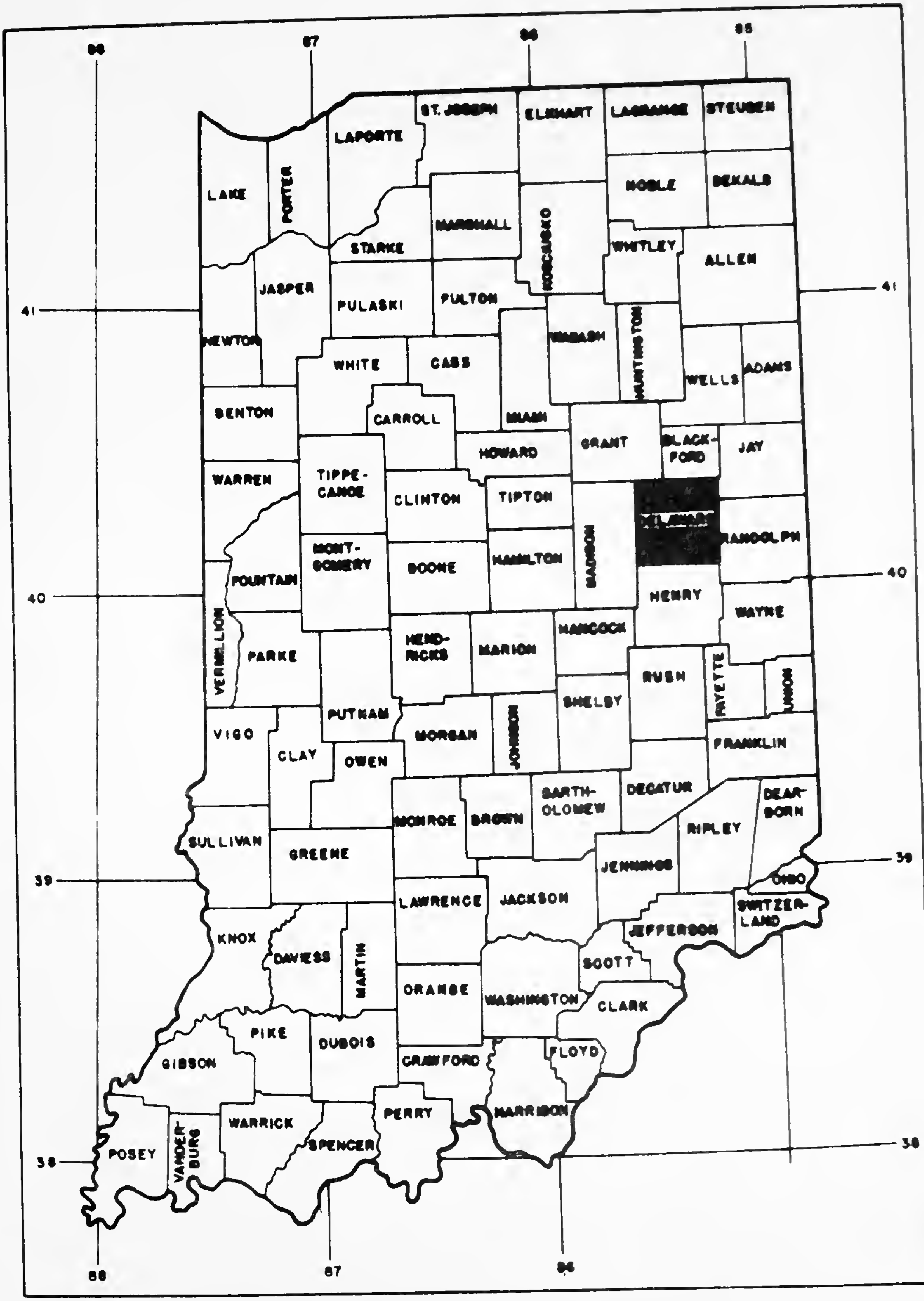


FIG. I. LOCATION MAP OF DELAWARE COUNTY

TABLE 1 (4)

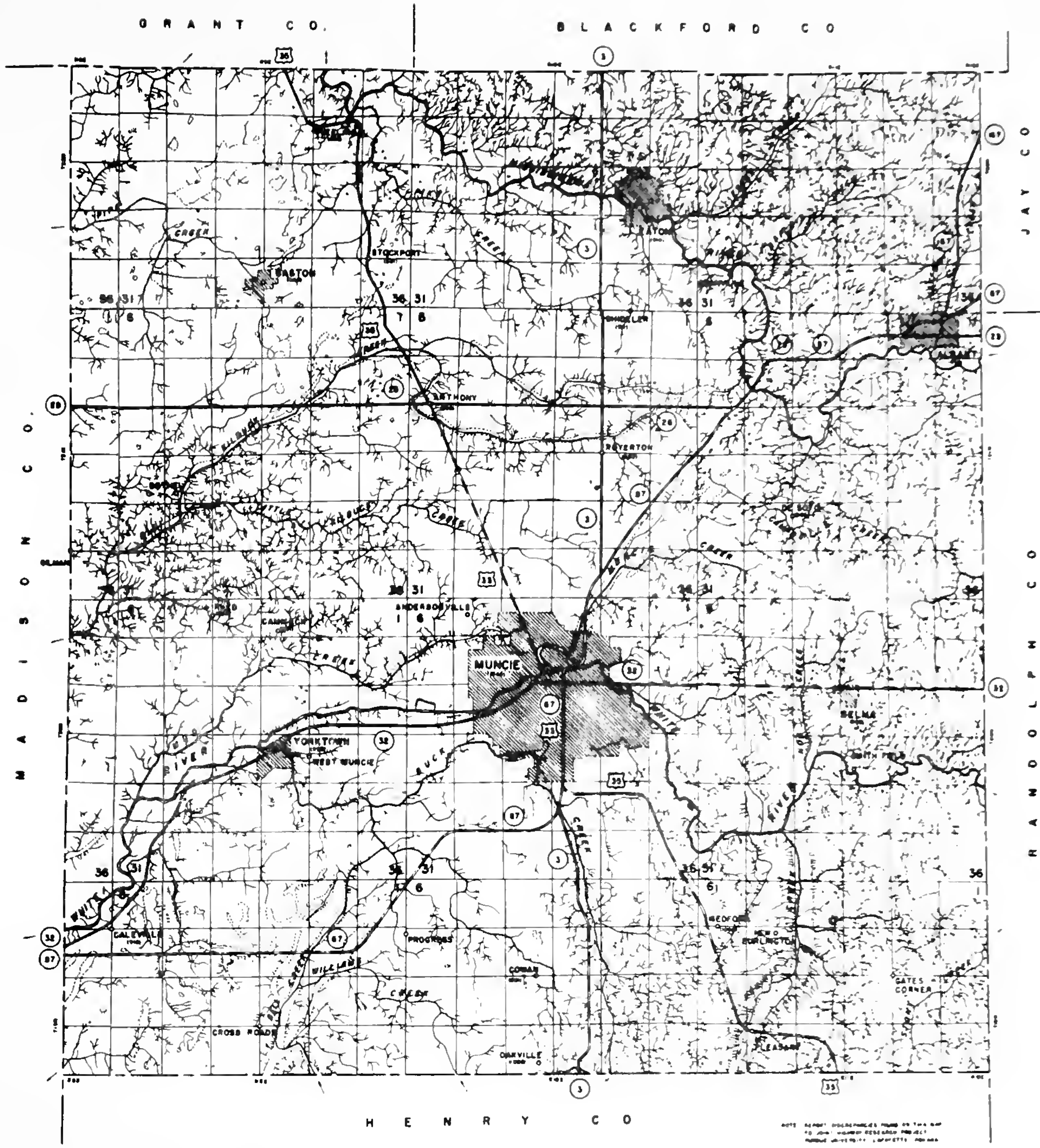
Some Significant Population Data for Delaware County

Population Cities and Towns	Population 1970	Population 1960	Percent Change '60-'70
Albany	2,293	2,132	7.6
Eaton	1,594	1,529	4.3
Gaston	928	801	15.9
Muncie	69,080	68,603	0.7
Selma	890	562	58.4
Yorktown	1,673	1,137	47.1
Cities & Towns	76,458	74,764	2.3
Rural Areas	52,761	36,174	45.9
County Total	129,219	110,938	16.5

DRAINAGE FEATURES

Drainage features of Delaware County are shown in Figure 2, "Drainage Map - Delaware County, Indiana", prepared by the Joint Highway Research Project, Purdue University, 1954 (13). Larger scale maps of one mile to the inch or two miles to the inch can be obtained by contacting the School of Civil Engineering. The following description of the drainage appears with the drainage map.

> "The northeastern third of Delaware County lies within the Mississinewa subdivision of the Wabash Drainage basin of the state. The remainder of the county is in the West Fork subdivision of the White River drainage basin (3).
>
> Surface drainage is best developed along the valleys of the White and Mississinewa rivers and their principal tributaries. The Mississinewa River valley is rather shallow. The watershed divide between the White and Mississinewa rivers is a nearly level plain tract. Another nearly level tract lies between Buck and Bell creeks in the southern part. Buck Creek is



DRAINAGE MAP

DELAWARE COUNTY

FIG. 2.

deflected near White River. Channels of glacial meltwater drainage are conspicuous within the county. These exist along Prairie, Hog, Buck, Bell, Muncie, Mud, Big Killbuck, and Easleys creeks. Stream valleys near the head of Bell Creek are shallow and fairly wide. Dissection is prominent along portions of Prairie, Stony, and Easleys creeks. The Prairie Creek valley in its upper portion is shallow. [Prairie Creek Reservoir was built in 1961.] The presence of sections of moraines appears to have affected drainage systems in the county. Stream deflection, local watershed divides, and intensified densities of drainage patterns occur in the morainic areas. Streams have shallow valleys near New Burlington. Many streams have tortuous courses. Prominent are some abrupt changes in the courses of the Mississinewa River. Several streams in the southern part also make abrupt changes in their courses; Bell Creek is an excellent example. Many streams in the southern part have northerly courses. White River has veered from the Union City moraine to flow down the dip of the underlying rock. Pike Creek nearly parallels the Mississinewa River. Streams in the northern part have a northwesterly trend exhibiting morainic control. Ditty Creek flows in a northeasterly direction before its course is reversed near White River. The headwater streams of Pipe Creek are deflected westerly. Local basins are scattered in the till plain areas.

There are no natural lakes in Delaware County. Ponds of various origins are scattered throughout the area.

Ditches have been constructed to improve sluggish drainage conditions.

A stream gaging station is located on White River at Muncie (12). The drainage area of White River above Muncie is about 300 square miles (11)." (12).

Two dams in the county are the Prairie Creek Reservoir Dam and the Muncie Water Works Dam.

CLIMATOLOGICAL SUMMARY

Muncie, the county seat of Delaware County, is also a weather station. The following two pages contain a climatological summary of Delaware County temperature and precipitation covering a 27-year (plus) period (1939-1966).

U.S. DEPARTMENT OF COMMERCE
ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION
IN COOPERATION WITH MUNCIE CHAMBER OF COMMERCE
CLIMATOGRAPHY OF THE UNITED STATES NO. 20-12

LATITUDE 40° 08' N.
LONGITUDE 85° 21' W.
ELEV (GROUND) 950 Ft.

CLIMATOLOGICAL SUMMARY

STATION MUNCIE, INDIANA

MEANS AND EXTREMES FOR PERIOD 1939-1966 x

Month	Temperature (°F)							**	Precipitation Totals (Inches)									Mean number of days					Month
	Means			Extremes				Mean degree days				Snow, Sleet					Precip. .10 inch or more	Temperatures				
																		Max.		Min.		
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year		Mean	Greatest daily	Year	Mean	Maximum monthly	Year	Greatest daily	Year		90° and above	32° and below	32° and below	0° and below	
(a)	28	28	28	28		28		16	46	46		46	46		46		46	28	28	28	28	
Jan.	36.5	19.6	28.1	73	1944	-19	1961	1157	2.79	3.07	1937	5.4	15.9	1927	9.0	1922	6	0	11	27	3	Jan.
Feb.	37.9	21.8	30.9	71	1954	-19	1951	938	2.10	2.38	1950	4.5	11.3	1965	8.0	1965	5	0	7	24	2	Feb.
Mar.	49.3	29.7	39.5	82	1939	- 9	1943	805	3.58	2.64	1963	3.9	18.5	1924	8.0	1942	7	0	3	20	*	Mar.
Apr.	62.3	40.1	51.2	88	1962+	15	1957+	406	3.84	2.35	1922	0.6	5.0	1931	5.0	1931	8	0	*	7	0	Apr.
May	73.8	49.9	61.9	95	1941	27	1947+	152	4.13	2.79	1936	T	T	1960+	T	1960+	8	1	0	1	0	May
June	82.9	59.4	71.2	101	1944	36	1945	22	4.38	4.35	1957	0	0		0		8	5	0	0	0	June
July	86.4	62.1	74.3	105	1940	44	1945+	1	3.59	2.27	1935	0	0		0		6	9	0	0	0	July
Aug.	85.2	60.2	72.7	103	1951	38	1946	6	3.46	3.91	1943	0	0		0		6	7	0	0	0	Aug.
Sept.	79.0	53.2	66.1	102	1939	25	1942	78	3.56	4.20	1965	0	0		0		6	3	0	1	0	Sept.
Oct.	68.3	43.3	55.8	91	1951	16	1952	308	2.66	3.02	1959	0.1	4.1	1925	2.6	1925	5	*	0	5	0	Oct.
Nov.	51.3	32.4	41.9	80	1950	- 6	1958	682	2.90	2.21	1955	2.3	17.1	1950	14.0	1950	6	0	1	16	*	Nov.
Dec.	39.3	23.1	31.2	69	1956	-17	1951	1035	2.58	2.21	1956	4.5	15.3	1929	5.3	1947	5	0	8	25	2	Dec.
Year	62.9	41.2	52.1	105	July 1940	-19 -19	1/1961 2/1951	5590	39.57	4.35	June 1957	21.3	18.5	Mar. 1924	14.0	Nov. 1950	76	25	30	126	7	Year

(a) Average length of record, years.

T Trace, an amount too small to measure.

** See Heating degree days paragraph below.

+ Also on earlier dates, months, or years.

* Less than one half.

x Precipitation data for period of 1921-1966.

CLIMATE OF MUNCIE, INDIANA

Muncie, located in Delaware County in East Central Indiana, enjoys an invigorating climate of four well defined seasons of the year because of its location in the middle latitudes and away from the influence of oceans. Air of both tropical and polar origin plies the area resulting in frequent changes of temperature and humidity and near ideal rainfall. Low pressure centers from the west cross the plains, move up the Ohio River Valley and the St. Lawrence River Valley to the Atlantic. Most of Muncie's rainfall comes from these storms. Afternoon thunderstorms are the primary source of summer rainfall. Days with these storms average about 47 a year. About one a year occurs during the winter months. Severe storms are rare but 17 tornadoes have been recorded in the County in the 50-year period of 1916-1966.

Relative humidity data is not available but estimates are possible. Relative humidity varies on an average summer day from the 40's during a typical summer afternoon to 90 or higher just before dawn. Relative humidity rises and falls much as temperature does during a 24-hour period but highest percent usually occurs with the minimum temperature and the lowest percent with the maximum temperature. In the winter the most probable range of humidity is from the 60's to the 90's. Southerly winds bring higher humidities than northwesterly winds.

Prevailing winds in the Muncie area are from the southwest during the year except in the winter and early spring when west and northwest directions are predominant. The mid-winter month of January has winds out of the northwest a majority of the time.

Rainfall intensities for the Muncie area, based on the statistical treatment of rainfall data, indicate that the probability of 1.3 inches of rain in one hour is about once in two years; a rain of 2.1 inches in one hour occurs about once in ten years, and 2.5 inches in one hour, about once in 25 years. In a 6-hour period, a rainfall of 2.0 inches occurs once in two years; 3.4 inches, once in a ten-year period, and 4.1 inches, about once in 25 years. In a 24-hour period a 2.8 inch rain occurs about once in two years; 4.3 inches fall once in ten years, and five inches fall about once in 25 years.

Precipitation is usually greatest in late spring and early summer. The winter months are the driest. April, May and June each average eight days having .10 inch or more of rain. The number of days, having this amount, drops to five in late summer and in the winter. Droughts are infrequent and effect agriculture only occasionally.

Snowfall has occurred as early as October and as late as May. The most snow comes in January; however, the greatest snowfall of any one day occurred November 26, 1950, when 14 inches were recorded. The greatest monthly total recorded occurred in March of 1924, with a total of 18.5 inches. The average yearly snowfall is 21.3 inches.

Temperature in July, the warmest month of the year, reaches 90 degrees or higher on an average of nine days a year. The winter season averages seven days with temperatures below zero. January is usually the coldest single month of the year. Muncie climate is cooler than western and southern Indiana.

Heating degree days in the table above provide a comparative number for calculating heating requirements between different places and different times. Fuel consumption for heating is proportional to degree day totals, so a month with twice the heating degree days of another month requires twice as much fuel for heating. Degree days for a single day are obtained by subtracting the mean temperature from 65 degrees.

The White River flowing through Muncie occasionally floods low lands. The river gauge, 200 feet down stream from the Walnut Street Bridge, would have read about 19.6 feet according to high water marks on March 25, 1913. This is the highest stage of record; next highest is 18.07 feet on January 15, 1937, and third highest of record is 10.98 feet on February 14, 1950. The zero of the river gauge near the bottom of the river is 920.10 feet above mean sea level.

July 1967

Lawrence A. Schaal
Weather Bureau State Climatologist
Purdue University Agronomy Department
Lafayette, Indiana 47907

Average Temperature (°F)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1939	33.8	32.0	41.6	48.0	64.8	73.6	74.4	72.8	71.6	55.9	39.2	33.8	53.4
1940	14.3	30.2	36.2	47.0	57.2	72.0	76.2	75.4	64.6	57.6	39.4	37.0	50.6
1941	29.2	26.6	33.8	55.4	63.9	70.3	74.5	72.0	69.2	58.0	43.0	36.9	52.8
1942	28.6	26.4	42.4	54.8	62.7	71.4	75.2	71.8	63.8	55.0	44.1	27.0	52.0
1943	28.4	31.5	36.5	47.4	62.0	74.7	74.2	72.8	61.4	53.0	38.7	29.0	50.8
1944	33.6	33.6	37.0	49.6	67.6	75.2	75.4	74.6	66.3	54.2	43.5	25.4	53.0
1945	21.6	31.3	52.4	53.3	56.4	69.0	72.0	71.6	67.4	52.2	43.1	24.2	51.2
1946	30.4	33.9	52.0	52.2	58.7	70.4	74.6	68.8	66.4	58.3	46.4	35.8	54.0
1947	33.6	22.1	33.0	50.6	58.6	68.0	70.4	78.4	66.8	61.6	38.0	30.9	51.0
1948	21.2	30.4	--	--	60.0	70.5	74.4	71.9	66.9	51.6	46.4	33.8	--
1949	34.7	35.5	42.0	51.4	62.5	73.1	77.7	73.2	60.3	59.0	41.9	35.6	53.9
1950	37.8	30.5	36.8	45.3	63.2	68.7	71.7	70.3	64.6	59.0	36.2	22.5	50.6
1951	30.4	30.1	41.8	50.3	63.1	70.0	73.1	71.2	63.5	57.9	34.7	29.8	51.3
1952	32.4	34.6	42.4	52.1	60.8	75.8	77.7	70.6	63.2	47.8	44.0	34.7	53.0
1953	33.5	35.8	42.6	47.7	64.6	75.1	74.9	73.1	67.2	57.5	43.5	33.3	54.1
1954	31.5	39.2	37.9	57.3	56.9	74.5	75.9	72.7	69.2	55.8	42.0	31.4	53.7
1955	27.2	31.9	42.0	57.7	63.9	66.6	78.1	75.1	67.9	55.4	38.9	28.2	52.8
1956	26.5	32.6	40.0	48.7	63.1	69.6	71.4	73.7	64.9	60.4	42.8	38.0	52.6
1957	23.7	35.6	40.0	53.2	62.2	71.6	74.7	72.8	65.0	50.8	42.1	35.7	52.3
1958	28.1	23.7	35.4	52.0	60.7	66.9	73.4	72.2	65.4	54.9	44.1	23.1	50.0
1959	24.8	30.1	39.0	51.8	66.6	72.1	74.0	77.1	68.5	55.0	38.4	36.0	52.9
1960	30.3	28.3	25.8	55.5	58.7	68.8	71.0	73.1	68.9	54.6	43.4	25.1	50.3
1961	23.9	35.4	44.0	46.2	57.3	68.4	73.0	71.7	70.0	57.4	42.6	29.4	51.6
1962	24.9	30.1	36.6	51.2	68.0	71.0	71.7	71.8	62.9	56.3	40.9	24.9	50.9
1963	18.9	21.8	41.7	52.3	60.4	--	--	--	--	61.5	45.4	--	--
1964	30.5	--	--	--	--	--	--	--	--	--	--	32.0	--
1965	28.2	28.5	33.6	51.8	68.7	71.6	72.9	71.4	67.4	53.9	43.9	36.7	52.4
1966	23.3	30.3	41.5	48.4	57.9	72.1	78.5	72.7	66.3	53.1	44.0	32.3	51.7
1967	32.2	24.9	41.6	54.7									

Total Precipitation (Inches)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1939	4.32	3.55	3.43	5.73	0.82	5.17	3.97	2.38	0.87	2.77	1.45	1.27	35.73
1940	1.27	1.84	1.08	5.67	3.50	1.45	2.23	1.71	0.78	2.89	2.64	2.08	27.14
1941	1.25	0.37	1.00	1.66	1.84	7.82	4.88	1.23	3.28	5.97	2.49	1.75	33.54
1942	0.89	2.39	5.14	3.19	3.80	3.14	4.65	2.55	3.54	1.05	4.13	1.88	36.35
1943	1.29	1.71	3.78	2.33	9.54	3.27	6.52	6.43	1.86	1.44	1.92	0.75	41.84
1944	0.18	2.46	4.49	5.99	4.81	1.62	1.04	3.43	1.99	0.77	2.45	1.24	30.47
1945	0.54	2.35	7.32	3.99	3.90	6.52	3.63	3.21	7.49	2.71	3.54	2.61	47.81
1946	1.20	2.65	2.85	1.80	5.75	4.72	3.50	2.25	0.52	3.27	3.45	3.00	34.96
1947	4.11	0.40	2.11	6.25	4.70	3.47	5.73	3.62	4.03	2.98	1.52	2.25	41.17
1948	2.23	2.16	--	--	3.63	6.35	3.01	2.62	3.26	2.98	4.49	3.66	---
1949	6.14	2.29	2.16	--	3.57	5.75	3.23	2.44	2.69	3.07	0.64	2.55	---
1950	11.07	5.98	3.44	3.48	2.99	5.94	4.64	3.80	4.78	1.42	6.42	2.22	56.18
1951	2.39	3.27	2.10	2.21	3.24	5.38	2.82	0.96	2.39	1.38	4.61	3.68	34.43
1952	3.93	2.12	4.49	4.24	4.24	3.54	1.38	4.06	6.66	0.79	3.36	2.44	41.25
1953	2.01	1.81	3.92	2.94	6.10	2.76	5.48	2.72	1.39	1.02	1.55	3.69	35.39
1954	2.50	2.66	2.49	2.46	3.56	2.96	2.76	6.56	0.19	10.52	2.00	1.98	40.64
1955	2.59	2.09	4.38	4.31	3.32	3.32	3.45	4.63	5.80	4.24	5.19	0.51	43.83
1956	1.52	3.04	1.93	6.18	5.07	2.51	3.02	2.47	0.66	0.83	2.20	4.65	34.08
1957	2.38	1.93	1.42	7.49	8.17	10.44	3.12	3.41	3.11	3.32	2.59	4.92	52.30
1958	0.75	0.63	1.20	2.69	4.80	11.40	5.35	3.30	3.35	1.26	4.10	0.30	39.13
1959	4.70	2.53	2.58	4.95	5.57	1.14	3.94	2.83	2.58	5.66	3.13	2.44	42.05
1960	3.29	3.30	0.86	2.14	4.89	3.59	2.74	4.66	1.97	1.61	2.26	1.21	32.52
1961	0.88	3.07	6.80	6.31	2.58	4.12	5.06	2.69	3.89	1.69	2.44	2.08	41.61
1962	4.67	1.85	2.67	0.60	4.61	2.39	7.98	4.77	0.77	3.26	1.58	0.34	35.49
1963	0.74	0.38	7.84	3.31	3.30	1.62	3.67	2.37	0.12	T	2.41	0.96	26.72
1964	1.30	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	2.94	
1965	4.66	3.63	2.95	4.87	1.69	1.40	1.99	2.83	7.29	4.27	1.18	1.31	38.07
1966	1.78	1.53	1.74	3.95	2.50	2.52	1.19	1.65	4.42	2.03	4.09	5.36	32.76
1967	2.03	1.77	4.60	4.23									

STATION HISTORY

The first known weather records taken at Muncie were in the periods of October 1863 through August 1864 and from August 1866 to May 1870. These records are in the files of National Archives. An incomplete record exists for the period of February 1, 1887 to February 28, 1895 when rainfall and temperatures were observed three times a day at the southwest corner of Walnut and Jackson Streets. Observers were T. E. Huston, A. L. Michener, Stevens and Durham. From September 1, 1916 through 1917 observations were provided by Harvey M. Anthony from a location opposite the Post Office. These were resumed October 1, 1920 and continued until November 30, 1921 by Mr. Anthony. Harry W. Hoppes is credited with a long record from December 1, 1921 through June 10, 1938 from an address of 417 University Avenue. Elevation above mean sea level of the various locations ranges from 939 feet to 960 feet. James C. Fidler was the observer at his home, 1620 West Jackson Street, from July 1, 1938 to September 8, 1939, when instruments were moved, to a location on Burlington Road, 4.5 miles southeast of the Post Office. The station was moved on September 18, 1962 to Muncie Airport which is 3.3 miles north of the Post Office and 937 feet above mean sea level. The next move was to Ball State University on December 1, 1964. From this location, 960 feet above mean sea level, where instruments are stationed on the roof of the Science Building, observations are recorded, under supervision of Professor William Stevenson, by the Science Department.

Daily values of temperatures and precipitation are published monthly in "Climatological Data--Indiana" by Environmental Data Service, Environmental Science Services Administration, U.S. Department of Commerce.

DATES OF CRITICAL TEMPERATURES IN SPRING AND FALL (1939-1966)

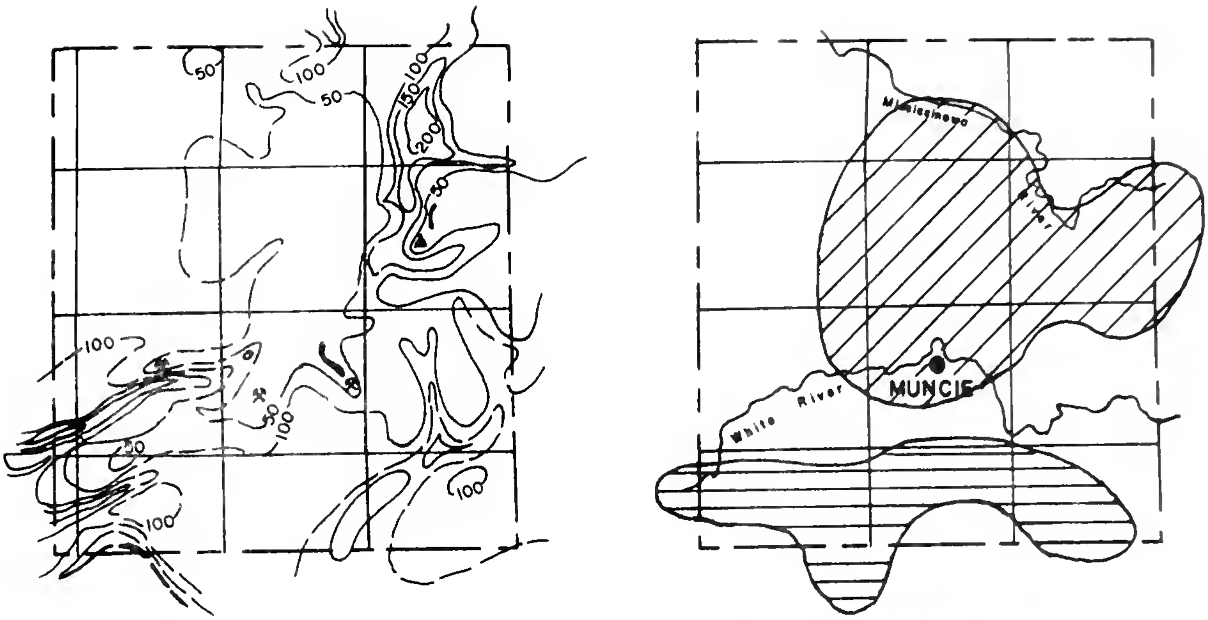
Minimum Temp.	Last in Spring: Earliest	Last in Spring: Average	Last in Spring: Latest	First in Fall: Earliest	First in Fall: Average	First in Fall: Latest
32°F. or lower	4/2/51	5/1	5/27/61	9/18/39	10/7	10/30/66
28°F. or lower	3/17/52	4/15	5/27/61	9/28/42	10/21	11/8/47
24°F. or lower	3/5/52	4/3	4/23/56	10/7/52	11/4	11/22/41
20°F. or lower	2/16/51	3/19	4/13/50	10/18/48	11/10	12/2/66
16°F. or lower	2/5/61	3/11	4/12/40	10/21/52	11/27	12/26/65

Example in using table: The average date of the last temperature of 32° or colder in the spring is May 1. The earliest date of this event in all springs of the 1939-1966 period was April 2, 1951. The latest date was May 27, 1961. Thirty-two degrees or lower occurred for the first time in the fall as early as September 18 in 1939 and as late as October 30 in 1966. The average date for this temperature in the fall is October 7.

Data was compiled by the U. S. Department of Commerce, Environmental Science Services Administration in cooperation with the Muncie Chamber of Commerce, July 1967 (14).

GLACIAL GEOLOGY

Ice covered Delaware County during at least three glacial ages: Kansan, Illinoian and Wisconsin. The thickness of the glacial drift deposited ranges from no cover, at a few bedrock exposures, to more than 200 feet of glacial drift over some preglacial valleys - see Figure 3. Average overall thickness, however, probably would average close to 100 feet (11). Only Wisconsin age drift is exposed at the surface of Delaware County. Surface drift in the southern part of the county is probably somewhat less than 20,000 years old - deposited during the Tazewell subage. Surface drift in about the northern part of the county is probably somewhat less than about 15,000 years old - deposited during the Cary subage. From various literature it appears that the Tazewell-Cary interglacial period could have ranged from 5000 to 12,500 years. Recent deposits such as: alluvial materials along streams, colluvial accumulations on slopes, swamps and lake sediments such as peat and muck and sand dunes are mostly less than 10,000 years old. Geologically these recent deposits are known as facies of the Martinsville Formation (9).



GLACIAL DRIFT THICKNESS (WAYNE - 1956)

GLACIAL DRIFT THICKNESS (GRAY - 1973)

50 Ft. Contour Interval

▲ Bedrock Outcrops

⚒ Quarry

Less Than 50 ft.

50 ft. To 200 ft.

Over 200 ft.

FIG. 3. GLACIAL DRIFT THICKNESS - DELAWARE CO.

The following summary of Wisconsin glaciation along with Figure 4 (9) provide an excellent picture of glacial history in all northern Indiana as well as Delaware County.

"The main advance of ice during the Wisconsin Age covered about two-thirds of Indiana (Fig. 4A). It reached its maximum position at the Shelbyville Moraine about 21,000 years ago, then the marginal area melted almost immediately. About 1,000 years later the ice margin moved back southward to a new position a little short of the Shelbyville Moraine (Fig. 4B). The advance buried a thin bed of silt that covered the older till. Fossil snails and plant remains in the silt show that central Indiana at that time probably was covered with tundra-like vegetation and scattered spruce trees. A few patches of permafrost may have existed close to the ice. This advance of the ice is marked by the Crawfordsville Moraine. The group of tills deposited by these two glacial advances are the Trafalgar Formation.

The ice that deposited the Trafalgar tills came from the northeast; striations and esker trough lineations show the direction the glacier was moving (Fig. 4B), and the till composition reflects the bedrock to the northeast into Canada. Large amounts of outwash sand and gravel were laid down during the advance and the building of the Crawfordsville Moraine, and kames were abundant. After the active ice margin had melted and the glacier had built the Knightstown Moraine, the entire lobe in central Indiana ceased to move. Kames, outwash plains, and moraines are the signature of an active glacier, but the eskers and esker troughs of central Indiana are evidence that the glacier became a mass of stagnant ice.

Another glacial advance followed the stagnation in central Indiana of the East White Sublobe of the Ontario-Erie Lobe. Ice moved first out of the Huron and Saginaw lowland across southern Michigan and north-central Indiana. The Maxinkuckee and Packerton Moraines are part of the varied topography of kames, moraines, outwash plains and kettles left by the Huron-Saginaw Lobe (Fig. 4C). Most of Indiana's lakes are the legacy of this advance.

Some masses of ice or ice-cored moraines of the Huron-Saginaw Lobe probably still lay in place to help block the north edge of the lobe that soon appeared from the Erie basin. The Ontario-Erie Lobe built the Mississinewa Moraine with its apex at Wabash, then as it melted, left a symmetrical series of recessional moraines around its former

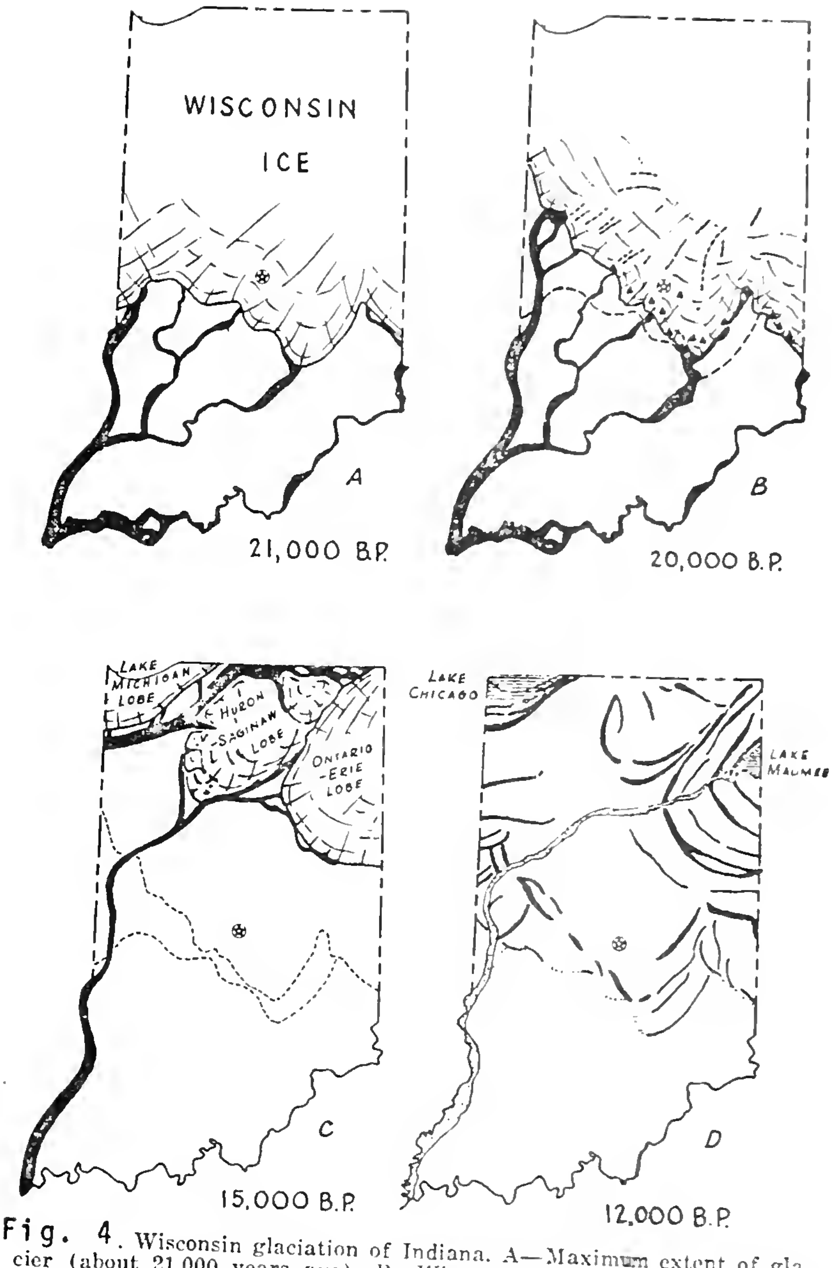


Fig. 4. Wisconsin glaciation of Indiana. A—Maximum extent of glacier (about 21,000 years ago). B—Wisconsin second maximum (about 20,000 years ago). C—Location of Wisconsin ice (about 15,000 years ago). D—Wisconsin morainal trends and extent of glacial Great Lakes (about 12,000 years ago). After Wayne (9)

BP - Before Present (1950 for radiocarbon dating)

positions (Fig. 4C). This till, clay-rich, is part of the Lagro Formation. After the ice melted from the Fort Wayne Moraine about 14,000 years ago, glacial Lake Maumee formed between the ice margin and the moraine (Fig. 4D). Its overflow spilled through the moraine and swept out a broad flood-plain, now called the Maumee Terrace, along the Wabash Valley.

At the same time that the Ontario-Erie Lobe was building its series of festooned moraines, glacial ice plowed southward again through the Lake Michigan basin. At its maximum extent it piled more till on an existing ridge to build the Valparaiso Moraine. Outwash drained to the Kankakee channel. As the ice margin melted, Lake Chicago came into existence between the glacier and the Valparaiso Moraine (Fig. 4D). Old beaches and stable dunes now mark its former levels" (9).

The main point to be gathered from the above is that an early lobe of ice coming out of Michigan (Tazewell subage) deposited slightly less clayey (slightly less plastic, slightly more silty, sandy, gravelly and bouldery) than a later ice lobe (Cary subage) coming out of the Erie basin area. The latter lobe deposited the slightly more clayey soil on top of the less clayey soil in the northern two thirds of the county.

Recently published geologic maps (1971) show the Largo Formation extending southward to include the Union City moraine (1). Some earlier geologic reports show the Largo Formation extending south only through the Mississinewa moraine. Pedologists call the primary soils of the Largo Formation Morley, Blount and Pewamo. These three soils were sampled in Delaware County by soil scientists and tested in Purdue's Civil Engineering soil laboratory - engineering test data is

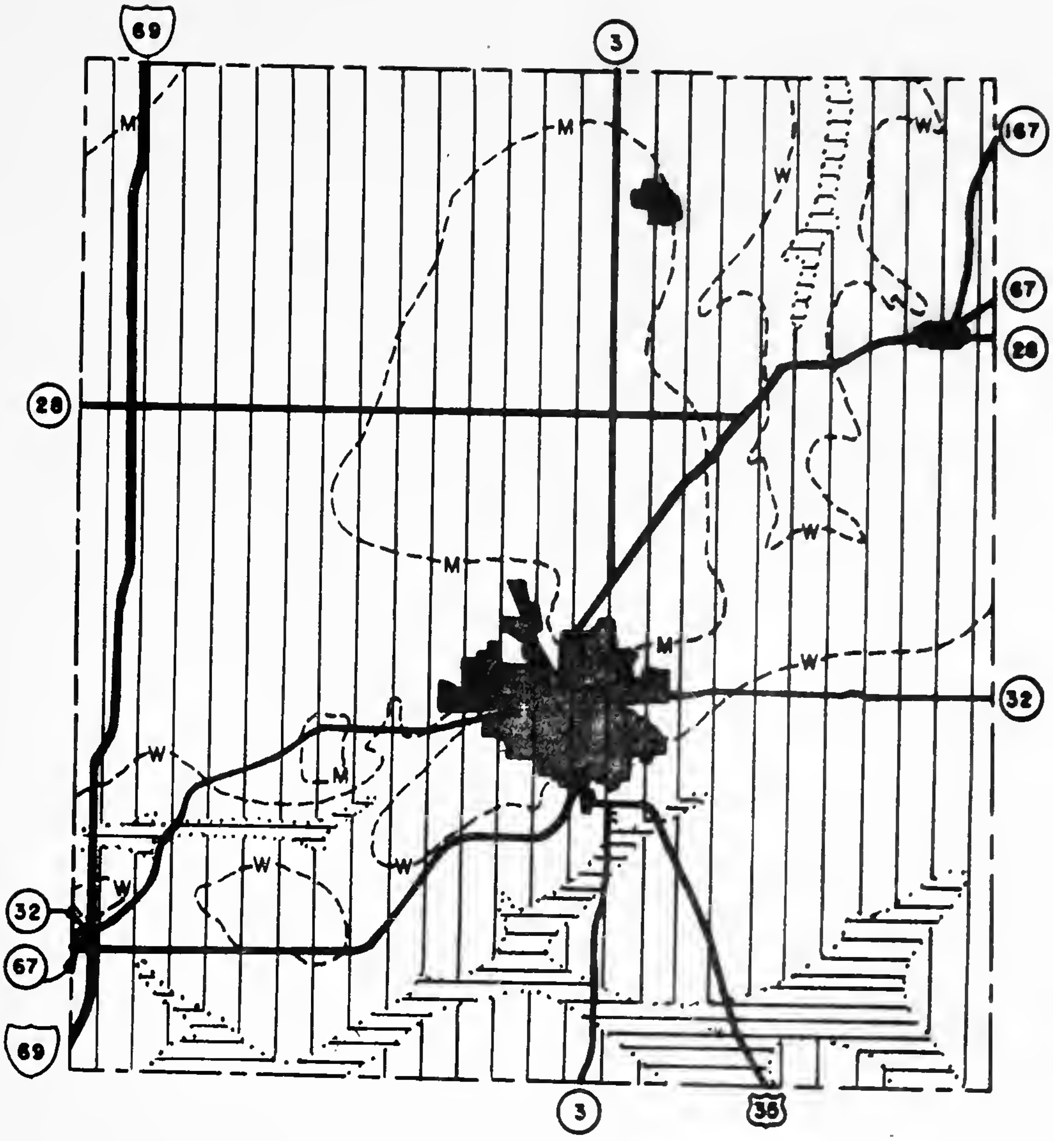
shown in Appendix A. South of the Union City Moraine the geologic formation is the Trafalgar Formation (Cartersburg Member). Pedologically the soils are mainly Miami, Crosby and Brookston soils.

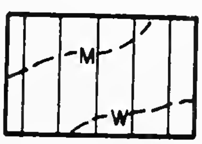
Geologic studies in Miami and Wabash counties (8)(12), with somewhat similar glacial geology features as Delaware County, report some minor fluctuations (advances and retreats) of the ice in the general area during both Tazewell and Cary subages with resulting interbedding of till and outwash material. In Delaware County, the outwash plains in the southern part of the county appear to show this interbedding. It appears that the outwash sand and gravels may have a thin veneer of till over them.

BEDROCK GEOLOGY

Figure 5 (1) shows a generalized bedrock geology map of Delaware County. Most of the rock is Silurian limestone, dolomite and shale. In the north central part of the county the Mississinewa Shale Member is at or near the bedrock surface. In the northeastern corner and also in the southern half of the county former stream branches of the Teays River have cut into Ordovician shale and limestone rock - compare the geology to the Glacial Drift Thickness map - Figure 3.

"Silurian rock formations are exposed in the Mississinewa valley near Eaton and in and near the valley of the West Fork of White River west of Muncie. Occasional bedrock valleys are present and appear to cross the county in a general north-south





EARLY AND MIDDLE SILURIAN AGE
Limestone, dolomite, and shale
M — base of Mississinew Shale Member
W — base of Waldron Formation

LATE ORDOVICIAN AGE
Shale and limestone

FIG. 5. GEOLOGIC MAP OF DELAWARE COUNTY

direction. The glacial drift thickens to the west and south in Delaware County. Morainic masses in the southern part of the county add to the thickness of glacial cover in this area" (McGrain).

Following is a 200-ft. rock section taken from an Indiana Geological Survey drilled core (6):

"Section 16. Exposure in abandoned quarry at site of cored hole and log of core from Indiana Geological Survey drill hole 96, near Yorktown, Delaware County, Ind. (SE1/4NW1/4SW1/4 sec. 14, T. 20 N., R. 9 E.). Altitude at top of section, 910 ft.

	Depth (ft)
Silurian System:	
Wabash Formation, Mississinewa Shale Member, 4.6 ft. examined:	
1. Dolomitic limestone, argillaceous, gray and olive drab, dense, earthy, weathering shaly; has conchoidal fracture; units 1 and 2 observed in exposure; this unit and its upward extension of a few feet at this site yielded the graptolites of Cumings and Shrock (1928a)...........	4.4-9.0
Louisville Limestone, 71.3 ft:	
2. Dolomite, gray, fine-grained, weathering slabby; has many crinoid fragments....	9.0-16.2
No observation...............	16.2-18.5
3. Dolomite, somewhat mottled light-gray and buff, strongly mottled below 48.0 ft; has ocherous stains to 42.0 ft; fine to medium grained, saccharoidal in part, vuggy; unit 3 and lower units observed in core; has lithology similar to that of reefs and, together with unit 2, is involved in local dips, so that Cumings and Shrock (1928a, p. 172) designated the site as showing reef development......	18.5-58.5

4. Dolomite, mostly buff, fine-grained, and vuggy, argillaceous in upper 2.5 ft, weakly stylolitic; has dark-colored irregular carbonaceous laminae; grades in lower foot to unit 5........................ 58.5-80.3

Waldron Formation, 5.6 ft:

5. Shale, dolomitic, dark-gray, especially fossiliferous in lower 6 in. and reminiscent of classic outcrop fossils; has fucoidal markings in part.......................... 80.3-85.9

Salamonie Dolomite, 85.7 ft:

6. Dolomite, light-colored, has ocherous stains in upper part; mostly fine grained saccharoidal; vuggy in upper two-thirds; somewhat stylolitic; has sparse corroded chert in upper part and abundant chert nodules and bands from 126.5 to 134.5 ft.; upper few inches consist of coquina of fossils as in unit 5; unit corresponds at least in part to Laurel Limestone of southern Indiana..... 85.9-134.5
7. Dolomite, argillaceous, gray, earthy, fine-grained; has many crinoid fragments, dark-colored irregular shaly laminae, and white nodular bands of corroded chert; units 6 to 8 correspond at least in part to the Osgood Formation of southern Indiana; grades into unit 8................... 134.5-151.3
8. Dolomite of variable aspect, gray and light-colored, fine-grained, saccharoidal in part, also coarse-grained, stylolitic and vuggy in part; has coarse crinoid fragments in upper and lower parts and some dark wavy carbonaceous laminae in lower part; grades into unit 9............ 151.3-171.6

Brassfield Limestone, 7.4 ft:

9. Dolomite, mottled gray and light gray-green, fine-grained, vuggy, pyritic; has some pinkish-tan streaks and crinoid fragments reminiscent of the Brassfield on outcrop 171.6-177.5
10. Dolomite, pyritic, tan and gray and fine- to coarse-grained, also gray-green and dense; unit possibly is Cincinnatian in age........ 177.5-179.0

Ordovician System, Cincinnatian Series:

Unassigned rocks, 20 ft cored:

11. Dolomite and shale, interbedded and mixed; dolomôte is gray and tan, fine to coarse grained, and fossil fragmental and grades to shale; shale is gray green; has characteristic Cincinnatian fossils; unit includes two 3-ft core losses.................... 179.0-190.0
12. Dolomite, tan to brassy-brown, medium-grained, somewhat vuggy, pyritic; has intercalations of green shale in upper part..... 190.0-199.0" (6).

The "Directory of Crushed Stone, Ground Limestone and Cement Producers in Indiana" (2) provides the following information on several limestone quarry operations in Delaware County: "Company - Irving Brothers Stone and Gravel Corporation; location - 1.75 mile northeast of S.R. 67 and S.R. 3; products - crushed limestone and agricultural limestone; geology - sand and gravel 50 ft., Louisville limestone 57.8 ft.; remarks - cored Waldron shale 9.2 ft., Salamonie dolomite 107 ft., Brassfield limestone 19.2 ft., Cincinnatian rocks 30.6 ft."

"J and K Stone Corporation - Eaton Quarry; location - west edge of Eaton; products - crushed limestone and aglime; capacity - 1000 tons per day; geology - soil plus glacial drift 3.5 ft., lower Niagaran rocks 29.1 ft.

"J and K Stone Corporation - Muncie Quarry, location - southwest of Muncie at Cornbread Road and Middletown Pike; products - crushed and agricultural limestone, also flux; capacity - 2,600 tons per day; geology - soil plus glacial drift 6 ft., Louisville limestone 60 ft.

"Muncie Stone and Lime Company Incorporated, Cornbread Road near Hoyt Avenue, products - crushed and aglime, capacity - 1,500 tons per day, geology - soil plus glacial drift 6.5 ft., Louisville limestone 76.6 ft." (2).

PHYSIOGRAPHY AND TOPOGRAPHY

Delaware County lies in the Central Lowlands province of the United States and in the Till Plains section of the province. In Indiana the Till Plains section is known as the Tipton Till Plains.

Figure 6 shows a physiographic sketch - namely the outstanding land form features of Delaware County. The physiographic sketch also shows a number of elevation points on various prominant land forms. Figure 7 is a generalized topographic map of Delaware County showing approximate 50-foot contour interval areas. Note the general elevations increases diagonally across the county from the northwestern corner (850-900 feet) to the southeastern corner (1050-1100 feet).

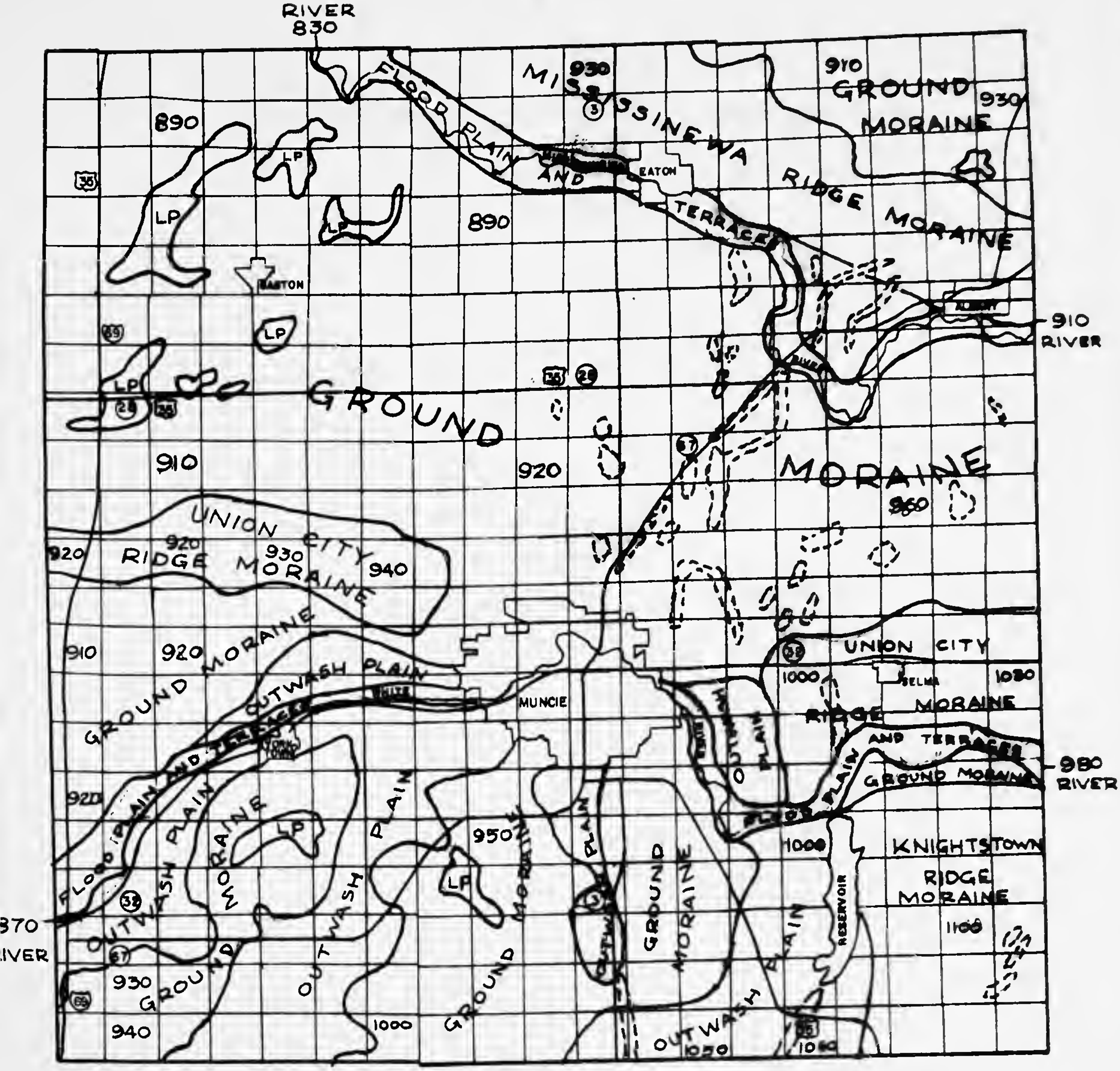


FIG. 6 . PHYSIOGRAPHIC SKETCH OF DELAWARE COUNTY

LP - LACUSTRINE PLAIN

- ESKERS

- KAMES

830 - 1100 - ELEVATIONS

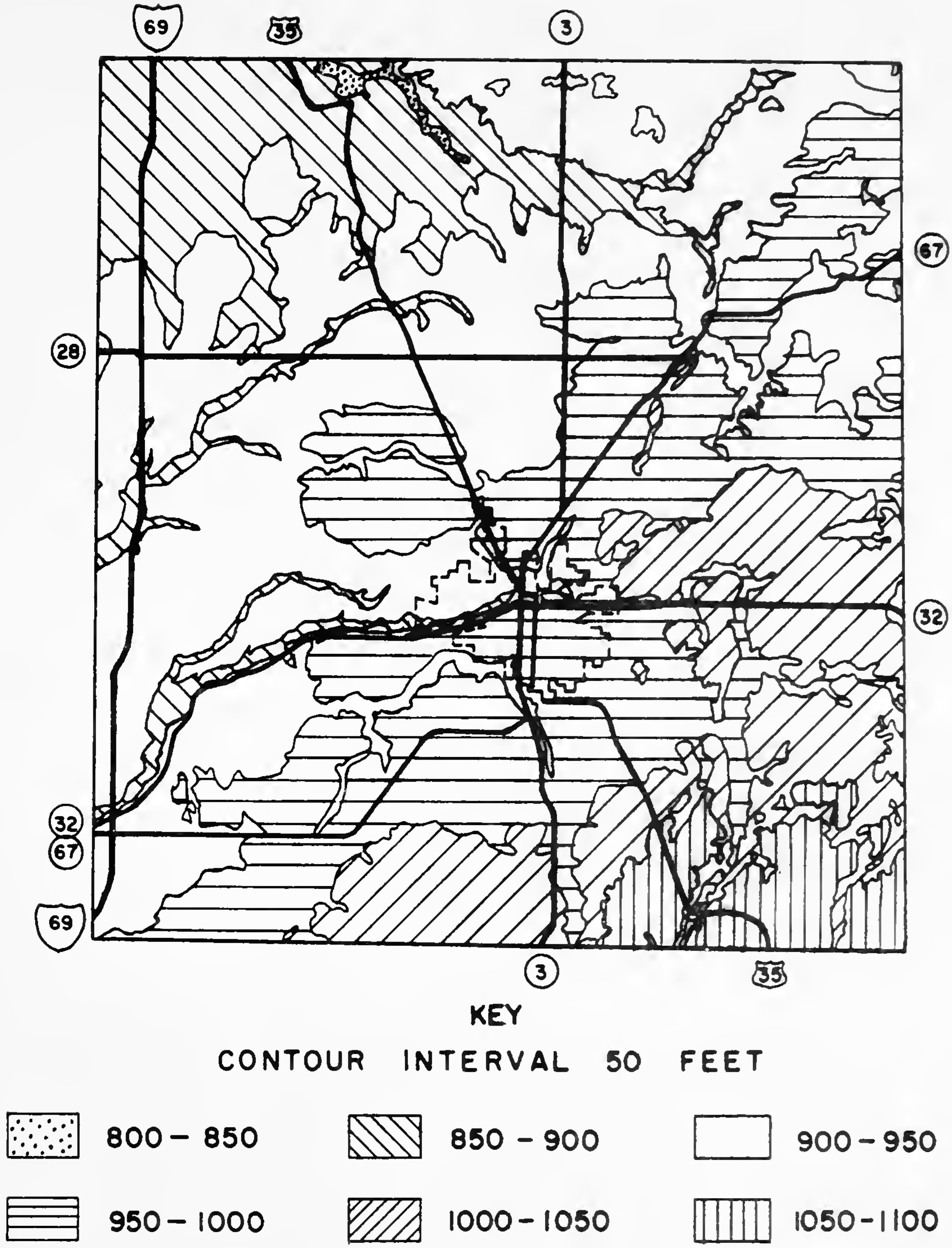


FIG. 7. TOPOGRAPHIC MAP OF DELAWARE COUNTY

(from 1° Topo Map NK 16 - 12)

The main land form features of the county are: two major rivers,with flood plains and terraces, three ridge moraines, three till plains, several outwash plains, a number of lacustrine plains, eskers, proglacial sluiceways and muck and peat deposits. The physiographic sketch, Figure 6, with all of the county's one-square mile sections shown, gives a good idea of the relative size (areal extent) and location of all the land forms. Some elevation points on the various land-forms provide some idea of general relief throughout the county.

Studying the physiographic sketch from north to south, it can be noted that a small portion of a gently undulating till plain is located in the northeastern corner of the county. General surface elevations range between 910 and 930 ft.

The next land form to the south is the Mississinewa ridge moraine which is about two and one-half miles wide. Its slope on the north is very gentle and almost imperceptible. On the south, however, where the ridge moraine borders the Mississinewa River, the south slope is somewhat more pronounced. In some places, relief from the flood plain to the crest of the ridge moraine is 40 to 50 ft. Crest elevation points along the Mississinewa ridge moraine range from 930 in the west to 970 in the east.

The Mississinewa River enters the county on the eastern border at an elevation of 910 ft. and leaves at the northern border at an elevation of 830 ft. - an 80-ft. drop in about 16 miles. As this part of the river is in the upper reaches, the flood plain is relatively narrow and not deeply incised. Terraces are not well developed, and especially on the south,

the terraces appear to grade gradually into the uplands. There are no sand dunes along the river.

South of the river is another portion of a large till plain. It extends entirely across the county and is six to nine miles wide. It is gently undulating to monotonously flat with several lacustrine plains in its western third. In its eastern third are a number of eskers and a few kames. Some of the eskers may have had a continuous length of many miles at one time - now the longest segments are about two miles long. Some of the eskers are 30 to 40 ft. high and are extensively mined (3). The middle third of the till plain contains several long and well defined, abandoned, glacial sluiceways.

South of the till plain is the very low and narrow Union City ridge moraine. It is about two miles wide and rises only ten to 20 ft. above adjacent plains. Its clayey slopes are extremely gentle and it was very difficult to draw its poorly defined boundary limits.

South of the ridge moraine is more of the Tipton Till Plain which contains: the West Fork White River, some large outwash plains, several creeks, several abandoned glacial sluiceways, the Prairie Creek Reservoir, a number of small lake beds and a few eskers and kames.

West Fork White River enters the eastern county boundary at elevation 980 ft. and leaves at the western boundary at 870 ft. - a drop of about 110 ft. in 25 miles. River terraces on the east are small and on the west they blend into a large surrounding outwash plain. Outwash plains bracket streams and old sluiceways in the southern third of the county.

In the extreme southeastern corner of the county is a portion of the Knightstown ridge moraine. It rises to an elevation of 1100 ft. which is about 50 to 60 ft. above adjacent outwash plains and till plains.

ENGINEERING SOIL AREAS

The soils of Delaware County can be divided into three major groups: (I) glacial or ice-contact soil deposits, (II) fluvial or water-deposited soils, and (III) peat and muck deposits. In the discussion that follows each of the major groups is further subdivided into land form parent material groups. These groups are further subdivided into soil textural groups for which pedological names are also provided. Using the pedological names and Appendices A, B and C, engineering properties and problems for all soil areas can be obtained.

I. GLACIAL DEPOSITED MATERIALS

The land forms of glacial, or ice-contact deposits in Delaware County include ground moraines, ridge moraines, eskers and kames.

(1) Ridge and Ground Moraine - Clayey Texture

The ridge and ground moraine parent material of the northern two-thirds of Delaware County is slightly more clayey than the southern one-third. The dividing line between the two different soil types is the southern edge of the Union City ridge moraine. In the east, the dividing line

follows the West Fork White River to Muncie and then follows the N and W Railroad tracks, slightly northerly, to the western boundary of the county.

The parent material of the northern two-thirds of the county, including the Union City ridge moraine, the large till plain to the north, the Mississinewa ridge moraine and the very small till plain in the north east corner of the county, is a very clayey soil from former glacial lakes in the northern part of Indiana and Ohio.

On the attached engineering soils map, general soil profiles for high and low topographic sites have been drawn and designated profile set No. 1. The soil classification used in all profiles is the one used by the Indiana State Highway Commission.

Parent materials of the northern two-thirds of the county are clays and silty clays and depth to the top of the C-horizon ranges from 20 to 60 in. The B-horizon soils are similar but usually slightly more plastic. Depth to the top of the B-horizon varies between 8 and 16 in. The A-horizon soils are clays, silty clays, silty clay loams and silt loams. Over much of the area loess materials may range to a depth of 18 in.

Pedologically the major soils of the area are Blount, Pewamo and Morley (except Morley MvB2 and MvC2). The areas of Blount and Pewamo are about equal while the Morley soils constitute less than ten percent of the area. The Pewamo

soils are in broad depressions and narrow fingerlike lows within areas of Blount soils which are nearly level or slightly sloping. The Morley soils occupy oval-shaped knolls at slightly higher elevations than Blount and Pewamo soils.

Soil samples of the A, B and C-horizons of each of the three soils, each at two sites, were taken in Delaware county. Samples were taken by the SCS and the Purdue Agricultural Experiment Station and tested in soil laboratories of the Purdue School of Civil Engineering. Location of test sites and the results of laboratory tests are shown in Appendix A. Additional test data on the same three soils were taken in other counties and these results are shown in Appendix B.

(2) Ridge and Ground Moraine - Clayey to Silty Texture

The second largest ridge and ground moraine soils area extends from the southern edge of the Union City ridge moraine to the southern boundary of the county. It is a clayey till that is somewhat more silty and sandy and less plastic than the till to the north.

A pedological description of a much larger region, that includes the area in Delaware County, reads as follows:

> "The soils are developed in a thin silt mantle less than 18 in. thick and clay loam till that has been leached of carbonates to a variable depth of 18 to 42 in. The unweathered loam till occurs at an average depth of 32 in. It is very compact and ranges from 15 to 30 percent in carbonate of lime. The soils consist of the well drained Miami, the moderately well drained Celina (not in Delaware County), the somewhat poorly drained Crosby and the poorly drained Bethel silt loams (not in Delaware County) and the very poorly drained Brookston and Kokomo silty clay loams of depressions. Bordering the deeper valleys there are minor areas of the neutral, shallow Hennepin soils on the steep

> slopes. Brookston and Crosby soils commonly known as "Black and Clay land" are the dominant soils of this region. Crosby silt loam, the more extensive soil, occurs on flat to gently undulating areas intermingled with dark colored Brookston silty clay loam of the depressions. Crosby has a grayish brown silt loam surface soil 8 to 10 in. thick that overlies a gray clay loam subsoil mottled with yellowish brown to a depth of about 30 in. Near the contact with the limy till, at average depth of 33 inches, there is a dark mottled yellowish brown neutral clay loam layer. The clay content of the subsoil ranges from 30 to 40 percent and averages about 34 percent...one principal problem is maintaining drainage for crops on the level and depressed areas" (9).

On the attached engineering soils map, general soil profiles for topographic highs and lows in the area have been designated as soil profile set No. 2. The profiles show that the parent material may be either clay, clay loam or loam and top of the C-horizon may range from about 2 ft. to 6 ft. The B-horizon is either clay or silty clay and its contact with the A-horizon ranges from 8 in. to 24 in. The A-horizon may be either clay, silty clay, silty clay loam or silt loam.

On undulating ground moraine and ridge moraine, the Miami soils (except MnA, MnB, and MnC2 - Appendices B and C) are on the slight knolls. Crosby soils (CrA) are intermediate between the Miami and Brookston soils (Br) in the low areas. Brookston silty clay loam, stony subsoils (Bs), are found in narrow glacial sluiceways as well as Kokomo silty clay loam, stratified substratum (Ko), and Kokomo mucky silt loam, stratified substratum (Km). The latter three soils are discussed in more detail in following pages of the report.

(3) Eskers and Kames

In the central eastern and southeastern part of the county there are numerous eskers and kames. These land forms are outlined with dashed lines on the soils map - the elongated forms are eskers and the more rounded forms are kames or clusters of small kames. Many of the eskers and kames are being mined for sand and gravel. The four largest sand and gravel pits are located on eskers. In one or two of the pits, limestone is found below the sand and gravel and limestone is quarried for crushed stone.

The sand and gravel parent material classifies as silty poorly graded gravel and/or silty poorly graded sand which is stratified and cross bedded. Overburden may be as shallow as 20 in. on the crests and as deep as 10 ft. on the lower sides of the eskers and kames.

The soils most commonly found on eskers and kames include the: Fox (FoC2, FoD2) and the Morley, gravelly substratum (MuC3, MuD2, MvB2, MvC2, MwC3). Qualitative soils data for these soils is provided in Appendix B and profile No. 3, on the soils map, graphically shows the soil horizon depths and textures.

II. FLUVIAL DEPOSITED MATERIALS

The fluvial deposited soils in Delaware County are grouped and tabulated below according to their land form and parent material texture:

Outwash Plains, Terraces and Valley Trains

Sandy and Gravelly

Sandy and Silty

Narrow Valley Trains (Glacial Sluiceways)

Gravelly Loam

Fine Sand and Silt

Clayey

Lacustrine Plains

Clayey

Fine Sand and Silt

Recent Alluvium

Silty and Sandy

(1) Outwash Plains - Sand and Gravel Texture

All the outwash plains are located in the southern one-third of the county mainly bordering rivers, streams and abandoned glacial sluiceways. The largest outwash plain areas are immediately west and southwest of Muncie along both sides of West Fork White River and Buck Creek. Another outwash plain area is located south and east of Muncie along Prairie Creek Reservoir and along Buck Creek.

Some river and stream terraces, especially along the western part of West Fork White River, were relatively small and indistinct topographically and thus they were mapped as parts of the larger outwash plains.

On the soils map the outwash material is represented by soil profile.No. 4. The profile shows that depths to a parent material of stratified sand and gravel may range from 20 in. to 120 in. From bridge borings on SR 67 bypass, it appears that outwash in this area is essentially all sand. There are indications that parent materials may be shallower and more gravelly closer to the streams. Depth to the top of the B-horizon generally ranges from 8 in to 13 in. and the soil may be a gravelly clay, loam, silty clay, or a clay loam. The A horizon may be either gravelly clay, loam, silt loam or a silty clay loam.

Pedologically the soils may be Fox (FsA, FsB, FoC2, FoC3, FxB3 or FxC3), or Ockley (OcA or OcB), or Miami, gravelly substratum (MmA, MmA, MnB or MnC2). The Miami soils constitute the great majority of the area, especially away from the streams, and are probably much more sandy than gravelly.

(2) <u>Outwash Plains - Sand and Silt Texture</u>

East of Muncie, within the large southern loop of the West Fork White River is an outwash area of stratified sand and silt. There are numerous other areas of stratified sand and silt in the outwash plains but most are too small to show on the map. The parent material, sometimes with a little gravel, is 40 to 55 in. deep and overlying A- and B-horizon materials ranges from clay to sandy loam - see profile No. 5 on the map.

Pedologically the soils belong to the Martinsville series, MeA, MeB and MdC2.

(3) <u>Terraces and Valley Trains - Sand and Gravel Texture</u>

Terrace and valley train sand and gravel deposits in Delaware County are relatively small. These deposits are found mainly along the Mississinewa River, West Fork White River, Killbuck Creek and Mud Creek.

Depth to sand and gravel parent material generally ranges between 20 in. and 65 in. and the B-horizon is down about 8 in. to 11 in. - see soil profile No. 6 on the map. The B-horizon material is either clay, gravelly clay or silty clay. The A-horizon is either gravelly clay, silty clay loam or silt loam.

Pedologically the soils are Fox (FsA, FsB, FoC2, FoD2, FxB3 and FxC3) and Ockley (OcA and OcB).

(4) <u>Terraces and Valley Trains - Gravelly Silt Loam Texture</u>

All along the Mississinewa River there are a number of terraces and valley train deposits that have primarily a gravelly silt loam parent material. On the soils maps the soil profile is shown by soil profile No. 7.

Parent material is found at a depth of 28 in. to 72 in. and it may be either a: gravelly silty clay loam, gravelly silt loam, gravelly sandy loam or possibly stratified sand and gravel. The B-horizon, at a depth of 7 in. to 15 in. may be either a: gravelly silt loam, gravelly clay loam, silty clay loam or clay. The A-horizon may be a: silt loam, silty clay loam, gravelly clay loam or clay.

Pedologically the soils are Crosby silt loam, stony subsoil (CsA), or Brookston silty clay loam, stony subsoil (Bs).

(5) <u>Alluvial Plains</u>

The two largest alluvial plain areas (bounded by sawteeth on the map) are along the two major rivers - the Mississinewa and West Fork White River. They are also found along Killbuck Creek, Buck Creek and Campbell Creek. Annual flooding should be anticipated within the sawtooth areas.

Parent material, at a depth of 26 in. to 50 in., is primarily silty and loamy but in a few places there may be stratified sand and gravel or loamy sand. Most material however is loam, silt loam, sandy loam and clay loam. The coarser parent material is generally in the topographic high nearer the streams - see profile set No. 8 on the map. The A- and B-horizons are mostly silt loams and clay loams and frequently the B-horizon is absent or not discernable.

Soil in the topographic highs are Genessee (Ge) Ross (Ro) and the lower level soils are Shoals (Sh) and Sloan (Sn).

(6) <u>Lacustrine Plains - Clayey Texture</u>

In the northwest corner of the county there are five clayey lacustrine plains. The three larger ones also contain peat and muck deposits. The land forms of the former lakes is not well defined - the lakes were probably more like shallow slack water basins.

The parent material of stratified clay, silty clay, silty clay loam and silt loam is at a depth of 42 in. to 78 in. The top of the B-horizon is 10 in. to 15 in. deep and is usually clay and the A-horizon is clay or silty clay - see soil profile No. 9. The primary soil series is the Pewamo silty clay loam, stratified substratum (Pf).

(7) Lacustrine Plains - Silty and Sandy Texture

In the southern two-thirds of the county there are a number of widely scattered lacustrine plains measuring just larger and smaller than about one square mile in area.

These particular lacustrine plains have a stratified sandy and silty parent material at a depth of about 42 in. to 60 in. Reportedly, in a few places, there are some commercial sand and gravel deposits under the lake deposited soils. The A- and B-horizons are primarily clays.

The soil series involved is the Rensselaer (Rc), and the profile is No. 10 on the map.

(8) Narrow Valley Trains - Glacial Sluiceways
Textures - (1) Fine Sand and Silt, (2) Gravelly Loam, and (3) Clayey

Most of the narrow valley trains, that formerly were glacial sluiceways, have a C-horizon of stratified fine sands and silts at a depth of 30 in. to 84 in. At some places sand and gravel is found below at depth of 5 ft. to 7 ft. The overlying soils are clays and silty clays with up to 10 in. of surface muck in some places. The sand and silty sluiceways are represented by soil profile No. 11. Pedologically the soils are mainly Rensselaer (Rc) with lesser Kokomo silty

clay loam, stratified substratum, (Ko), and even lesser Kokomo mucky silt loam, stratified substratum, (Km).

Other sluiceways, represented by profile No. 12 have a gravelly loam, gravelly sandy loam and gravelly silt loam C-horizon at 30 in. to 60 in. The A- and B-horizons are mainly clays. The B has some gravel and stones. The soil series is Brookston silty clay loam, stony subsoil (Bs).

A very few of the sluiceways are clayey and are represented by profile No. 13. The parent material, at 42 in. to 78 in. are stratified clays, silty clays, silty clay loams and silt loams. The soil series is Pewamo silty clay loam, stratified substratum, (Pf).

PEAT AND MUCK DEPOSITS

The so-called peat and muck deposits, shown as solid black on the map, range from only slightly or partially decomposed vegetable matter, usually with some mineral material, to possible commercial type deposits of peat. Only insignificant deposits of marl have been reported in the county. Some mapped areas will have as much as 17 in. of silt loam at the surface over the unstable peat and/or muck materials - see the Wallkill (Wa) soil series described in the Appendices. Other soils include the Carlisle (Ca) and the Linwood (Ln).

The larger deposits are found in the northwestern quadrant of the county with lesser amounts in the southwest and southeast. Many of the deposits are known to be at least 5 ft. deep.

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    F-892 (1) P.E. F-892(3) Const.
    F-892 (1) P.E. F-892(5) Const.
    F-892 (1)

TABLE 5.—*Engineering*

[Tests performed by Purdue University in cooperation with Indiana State Highway Department and U.S. Department of Commerce,

Soil name and location [1]	Depth	Moisture-density data [2]		Mechanical analysis [3]		
		Maximum dry density	Optimum moisture	Percentage passing sieve—		
				¾-in.	⅜-in.	No. 4 (4.7 mm.)
Blount silt loam:	*Inches*	*Lb./cu. ft.*	*Percent*			
NE¼NW¼ sec. 9, T. 22 N., R. 11 E. (Finer textured C horizon than modal.)	0–6	98	22	----------	----------	100
	19–32	98	23	----------	----------	100
	32–44	104	19	100	99	98
NE¼SE¼ sec. 8, T. 22 N., R. 10 E. (Modal.)	0–7	96	23	----------	----------	----------
	18–27	99	22	----------	----------	----------
	27–33	106	18	----------	----------	100
Morley silt loam:						
NE¼NW¼ sec. 9, T. 22 N., R. 11 E. (Finer textured and thinner A horizon than modal.)	0–5	94	24	----------	100	99
	10–20	99	22	----------	100	99
	29–34	117	14	100	97	95
NW¼SW¼ sec. 9, T. 22 N., R. 10 E. (Modal.)	0–7	99	22	----------	100	99
	14–21	99	22	----------	100	99
	21–31	119	15	100	99	95
Pewamo silty clay loam:						
NW¼NW¼ sec. 9, T. 22 N., R. 11 E. (Coarser textured B horizon than modal.)	13–24	101	21	----------	----------	100
	24–34	103	19	----------	----------	100
	47–78	113	12	100	99	98
NW¼SW¼ sec. 9, T. 22 N., R. 10 E. (Modal.)	0–6	94	25	----------	----------	100
	19–34	111	16	----------	100	99
	45–56	114	13	100	98	94

[1] Parent material of the tested soils is calcareous till of Wisconsin age.
[2] Based on AASHO Designation T 99-57, Methods A and D (*1*).
[3] Mechanical analyses according to the AASHO Designation T 88-57(*1*). Results by this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2

'est data

3ureau of Public Roads (BPR), in accordance with standard procedures of the American Association of State Highway Officials (AASHO) (1)

Mechanical analysis [3]—Continued							Liquid limit	Plasticity index	Classification	
Percentage passing sieve—Con.			Percentage smaller than—							
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.			AASHO	Unified [4]
99	94	87	86	70	28	18	39	13	A-6(9)	CL or OL
98	96	89	87	80	61	47	53	27	A-7-6(17)	MH-CH
95	91	85	84	77	59	45	45	23	A-7-6(14)	CL
100	97	93	89	76	33	19	34	11	A-6(8)	CL or OL
----------	100	99	98	97	70	52	54	32	A-7-6(19)	CH
99	98	97	96	90	62	40	36	16	A-6(10)	CL
98	93	81	78	65	38	24	38	14	A-6(10)	CL
98	95	86	84	78	64	51	51	26	A-7-6(17)	CH
90	85	76	73	65	47	34	34	15	A-6(10)	CL
98	94	84	80	62	35	21	37	15	A-6(10)	CL
92	88	81	79	74	59	50	53	30	A-7-6(19)	CH
87	80	68	66	58	36	24	32	15	A-6(9)	CL
99	98	87	84	75	52	40	53	29	A-7-6(18)	MH-CH
99	97	87	85	76	51	40	50	26	A-7-6(16)	CH
95	89	78	75	67	49	35	36	17	A-6(11)	CL
99	98	90	87	77	53	39	50	18	A-7-5(13)	OH
98	96	88	87	78	56	45	49	28	A-7-6(17)	OL
90	84	72	69	58	39	29	38	19	A-6(11)	CL

iillimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser ian 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not iitable for use in naming textural classes for soils.

[4] SCS and BPR have agreed to consider that all soils having plasticity indexes within two points from A-line are to be given a borderne classification. An example of borderline classification obtained by this use is MH-CH.

TABLE 6.—*Estimated engineering*

Not included in this table because their characteristics are too variable to be classified, are the land types Borrow pits (Bp), Gravel pits not be applicable.

Soil series and map symbols	Depth to seasonal high water table	Depth from surface (representative profile)	Classification		
			Dominant USDA texture	Unified	AASHO
	Feet	*Inches*			
Blount: BlA, BlB, BlB2	[1] 1–3	0–9	Silt loam	ML or CL	A–4 or A–6
		9–33	Silty clay	CL or CH	A–7
		33–60	Clay loam or silty clay loam	CL or CH	A–6 or A–7
Brookston: Br	0–3	0–12	Silty clay loam	CL	A–6
		12–50	Silty clay loam or clay loam	CL or CH	A–6 or A–7
		50–60	Loam or silt loam	ML or CL	A–4 or A–6
Bs	0–3	0–10	Silty clay loam	CL	A–7
		10–34	Silty clay loam, clay loam, or gravelly clay loam.	CL or CH	A–6 or A–7
		34–60	Gravelly sandy loam, gravelly loam, or gravelly silt loam.	SM	A–2
Carlisle: Ca	0–2	0–31	Muck	Pt	
		31–60	Peat and muck	Pt	
Crosby: CrA	[1]1–3	0–9	Silt loam	ML or CL	A–4 or A–6
		9–32	Silty clay loam or clay loam	CL or CH	A–6 or A–7
		32–60	Loam or silt loam	ML or CL	A–4 or A–6
CsA	[1]1–3	0–11	Silt loam	ML or CL	A–4 or A–6
		11–40	Silty clay loam, clay loam, or gravelly clay loam.	CL or CH	A–6 or A–7
		40–60	Gravelly sandy loam, gravelly loam, or gravelly silt loam.	M or CL	A–4 or A–6
Fox: FoC2, FoD2, FsA, FsB	>5	0–11	Silt loam or loam	CL	A–4
		11–39	Clay loam or gravelly clay loam	CL or SC	A–6
		39–60	Stratified gravel and sand	SM–SP or GM–GP	A–1
FxB3, FxC3	>5	0–8	Gravelly clay loam	CL	A–6 or A–7
		8–34	Clay loam or gravelly clay loam	CL or SC	A–6 or A–7
		34–60	Stratified gravel and sand	SM–SP or GM–GP	A–1
Genesee: Ge	>5	0–26	Silt loam	ML or CL	A–4 or A–6
		26–60	Silt loam, loam, or sandy loam	ML or CL	A–4 or A–6
Hennepin: HeE	>5	0–3	Loam	ML or CL	A–4 or A–6
		3–14	Clay loam, silty clay loam, or silt loam.	CL or ML	A–6
		14–60	Loam, silt loam, or clay loam	ML or CL	A–4 or A–6
Kokomo: Km	0–3	0–9	Mucky silt loam	OL	A–4
		9–36	Silty clay loam or silty clay	CL or CH	A–6 or A–7
		36–60	Stratified sand and silt, with some clay and gravel.	SM or ML	A–4
Ko	0–3	0–16	Silty clay loam	CL or CH	A–6 or A–7
		16–37	Silty clay, clay loam, or silty clay loam.	CL or CH	A–6 or A–7
		37–60	Stratified sand and silt, with some clay and gravel.	SM or ML	A–2 or A–4

properties of the soils

nd Stone quarries (Gp), and Made land (Ma). Absence of an entry in a column indicates that a determination was not made, or it would >=greater than]

Percentage passing sieve—			Permeability	Available moisture capacity	Reaction	Frost-heave potential	Shrink-swell potential
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)					
			Inches per hour	*Inches per inch of soil*	*pH value*		
100	90–100	70–90	0. 63–2. 0	0. 17–0. 19	6. 1–6. 5	Moderate	Low.
100	95–100	90–95	0. 06–0. 2	0. 18–0. 20	5. 5–7. 4	Moderate or high	High.
100	90–100	70–95	0. 2–0. 63	0. 17–0. 19	7. 4–8. 4	Moderate	Moderate.
100	95–100	85–95	0. 2–0. 63	0. 18–0. 20	6. 6–7. 3	Moderate	Moderate.
100	95–100	85–90	0. 06–0. 2	0. 18–0. 20	6. 6–7. 3	Moderate	Moderate.
100	85–100	60–90	0. 2–0. 63	0. 17–0. 19	7. 4–8. 4	Moderate	Low.
100	95–100	85–95	0. 2–0. 63	0. 18–0. 20	6. 6–7. 3	Moderate	Moderate.
90–100	70–80	80–90	0. 06–0. 2	0. 18–0. 20	6. 6–7. 3	Moderate	Moderate.
70–80	44–55	25–35	2. 0–6. 3	0. 14–0. 17	7. 4–8. 4	Moderate	Low.
----------	----------	----------	2. 0–6. 3	>0. 25	6. 0–7. 3	Low	Low.
----------	----------	----------	2. 0–6. 3	>0. 25	6. 5–7. 3	Low	Low.
100	90–100	70–90	0. 63–2. 0	0. 17–0. 19	5. 6–6. 5	Moderate or high	Low.
100	95–100	85–95	0. 06–0. 2	0. 18–0. 20	5. 5–7. 5	Moderate	Moderate.
100	85–100	60–90	0. 2–0. 63	0. 16–0. 18	7. 4–8. 4	Moderate	Low.
100	90–100	70–90	0. 63–2. 0	0. 17–0. 19	5. 6–6. 5	Moderate or high	Low.
90–100	80–90	65–75	0. 06–0. 2	0. 18–0. 20	5. 6–6. 0	Moderate	Moderate.
75–85	65–75	50–65	2. 0–6. 3	0. 14–0. 17	7. 4–8. 4	Low	Low.
100	90–100	70–90	0. 63–2. 0	0. 17–0. 19	5. 6–6. 0	Moderate	Low.
90–100	70–80	35–55	0. 63–2. 0	0. 18–0. 20	5. 6–6. 0	Moderate	Moderate.
50–70	15–30	5–10	6. 3–20. 0	0. 03–0. 06	7. 4–8. 4	Low	Very low.
70–80	60–70	55–65	0. 2–0. 63	0. 18–0. 20	5. 6–6. 0	Moderate	Low.
75–85	60–70	45–55	0. 63–2. 0	0. 18–0. 20	5. 6–6. 0	Moderate	Moderate.
50–70	15–30	5–10	6. 3–20. 0	0. 03–0. 06	7. 4–8. 4	Low	Very low.
100	90–100	70–90	0. 63–2. 0	0. 17–0. 19	7–4–8. 4	Moderate	Low.
100	60–95	50–80	0. 63–2. 0	0. 14–0. 19	7. 4–8. 4	Moderate	Low.
100	90–100	70–90	0. 63–2. 0	0. 17–0. 19	6. 1–6. 5	Moderate or high	Low.
100	90–100	70–80	0. 63–2. 0	0. 18–0. 20	6. 1–6. 5	Moderate	Low or moderate.
100	85–100	60–80	0. 63–2. 0	0. 16–0. 18	7. 4–8. 4	Moderate	Low.
100	95–100	85–95	0. 63–2. 0	0. 19–0. 21	6. 6–7. 3	Moderate	Moderate.
100	95–100	85–95	0. 06–0. 2	0. 18–0. 20	6. 6–7. 3	Moderate	Moderate or high.
90–100	60–80	45–80	2. 0–6. 3	0. 14–0. 17	7. 4–8. 4	Moderate	Low.
100	95–100	85–95	0. 2–0. 63	0. 18–0. 20	6. 6–7. 3	Moderate	Moderate.
100	95–100	85–95	0. 06–0. 2	0. 18–0. 20	6. 6–7. 3	Moderate	Moderate or high.
90–100	60–80	25–65	2. 0–6. 3	0. 14–0. 17	7. 4–8. 4	Moderate	Low.

TABLE 6.—*Estimated engineering*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface (representative profile)	Classification		
			Dominant USDA texture	Unified	AASHO
	Feet	*Inches*			
Linwood:					
Lm	0–2	0–26	Muck	Pt	
		26–60	Silt loam, loam, or sandy loam	ML or CL	A-4 or A-6
Martinsville:					
MdC2	>5	0–11	Sandy loam	SM	A-4 or A-2
		11–47	Clay loam, sandy clay loam, or sandy loam.	CL or SC	A-6
		47–60	Stratified sand and silt with some gravel.	SM-SP	A-2
MeA, MeB	>5	0–10	Loam	ML or CL	A-4 or A-6
		10–43	Silty clay loam, clay loam, or sandy clay loam.	CL or CH	A-6 or A-7
		43–60	Stratified sand and silt with some gravel.	SP-SM	A-2
Miami:					
MmA, MmB2, MmC2, MmD.	>5	0–12	Silt loam	ML or CL	A-4 or A-6
		12–36	Clay loam or silty clay loam	CL or CH	A-6 or A-7
		36–60	Loam or silt loam	ML or CL	A-4 or A-6
MnA, MnB, MnC2	>5	0–12	Silt loam	ML or CL	A-4 or A-6
		12–40	Silty clay loam or clay loam	CL or CH	A-6 or A-7
		40–50	Loam or silt loam	ML or CL	A-4
		50–120	Stratified gravel and sand	GM-GP	A-1
MoA, MoB	>5	0–10	Silt loam	ML or CL	A-4 or A-6
		10–40	Clay loam	CL or SC	A-6 or A-4
		40–60	Clay loam or silty clay loam	CL or CH	A-6 or A-7
MrB3, MrC3	>5	0–8	Clay loam or silty clay loam	CL or CH	A-6 or A-7
		8–34	Clay loam or silty clay loam	CL or CH	A-6 or A-7
		34–60	Loam or silt loam	ML or CL	A-4 or A-6
Morley:					
MuB, MuB2, MuD2	>5	0–7	Silt loam	ML or CL	A-4 or A-6
		7–25	Silty clay or silty clay loam	CL or CH	A-7
		25–60	Clay loam or silty clay loam	CL or CH	A-6
MvB2, MvC2	>5	0–8	Silt loam	ML or CL	A-4 or A-6
		8–26	Silty clay or silty clay loam	CL or CH	A-7
		26–48	Clay loam or silty clay loam	CL or CH	A-6
		48–120	Stratified gravel and sand	GP-GM	A-1
MwB3, MwC3	>5	0–6	Silty clay loam	CL or CH	A-6 or A-7
		6–22	Silty clay or silty clay loam	CL or CH	A-7
		22–60	Clay loam or silty clay loam	CL or CH	A-6 or A-7
Ockley:					
OcA, OcB	>5	0–10	Silt loam	ML or CL	A-4 or A-6
		10–49	Silty clay loam or clay loam	CL or CH	A-6 or A-7
		49–60	Stratified gravel and sand	GP-GM	A-1
Pewamo:					
Pe, Pk (For properties of Brookston soils in mapping unit Pk, see Brookston series in this table.)	0–3	0–12	Silty clay loam or silt loam	CL or CH	A-6, A-4, or A-7
		12–45	Silty clay	CL or CH	A-6 or A-7
		45–60	Clay loam or silty clay loam	CL	A-6 or A-7
Pf	0–3	0–10	Silty clay loam	CL or CH	A-6 or A-7
		10–42	Silty clay loam	CL or CH	A-7
		42–60	Silt loam or silty clay loam	CL or ML	A-6 or A-4
Rensselaer:					
Rc	0–3	0–12	Silty clay loam	CL or CH	A-6 or A-7
		12–41	Silty clay loam or clay loam	CL or CH	A-7
		41–60	Stratified sand and silt	SM	A-2

properties of the soils—Continued

Percentage passing sieve— No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	Permeability	Available moisture capacity	Reaction	Frost-heave potential	Shrink-swell potential
			Inches per hour	*Inches per inch of soil*	*pH value*		
			2. 0–6. 3	>0. 25	5. 6–6. 5	Low	Low.
100	85–100	60–90	0. 63–2. 0	0. 17–0. 19	7. 4–8. 4	Moderate	Low.
100	60–70	30–40	0. 63–2. 0	0. 13–0. 15	5. 6–6. 0	Moderate	Low.
100	60–90	35–55	0. 63–2. 0	0. 18–0. 20	5. 6–6. 0	Moderate	Moderate or low.
90–100	50–70	5–12	6. 3–20. 0	0. 11–0. 15	7. 4–8. 4	Low	Low.
100	90–100	70–90	0. 63–2. 0	0. 17–0. 19	5. 6–6. 5	Moderate or high	Low.
100	90–100	70–90	0. 63–2. 0	0. 18–0. 20	5. 0–7. 3	Moderate	Moderate.
90–100	50–70	5–12	2. 0–6. 3	0. 11–0. 15	7. 4–8. 4	Low	Low.
100	90–100	70–90	0. 63–2. 0	0. 17–0. 19	6. 1–6. 5	Moderate or high	Low.
100	90–100	70–80	0. 63–2. 0	0. 18–0. 20	5. 6–6. 0	Moderate	Moderate.
100	85–95	60–75	0. 63–2. 0	0. 16–0. 18	7. 4–8. 4	Moderate	Low.
100	90–100	70–90	0. 63–2. 0	0. 17–0. 19	6. 1–6. 5	Moderate or high	Low.
100	90–100	70–80	0. 63–2. 0	0. 18–0. 20	5. 6–6. 0	Moderate	Moderate.
100	85–95	60–75	0. 63–2. 0	0. 16–0. 18	7. 4–7. 8	Moderate	Low.
35–45	20–30	5–15	6. 3–20. 0	0. 03–0. 05	7. 4–8. 4	Low	Very low.
100	90–100	70–90	0. 63–2. 0	0. 17–0. 19	6. 1–6. 5	Moderate or high	Low.
95–100	70–80	35–55	0. 63–2. 0	0. 18–0. 20	5. 6–6. 0	Moderate	Moderate.
100	90–100	70–80	0. 63–2. 0	0. 17–0. 19	7. 4–8. 4	Moderate	Moderate.
100	90–100	70–80	0. 2–0. 63	0. 18–0. 20	5. 6–6. 0	Moderate or high	Moderate.
100	90–100	70–80	0. 63–2. 0	0. 18–0. 20	5. 6–6. 0	Moderate	Moderate.
100	85–95	60–75	0. 63–2. 0	0. 16–0. 18	7. 4–8. 4	Moderate	Low.
100	90–100	70–90	0. 63–2. 0	0. 17–0. 19	6. 1–6. 5	Moderate or high	Low.
100	95–100	90–95	0. 06–0. 2	0. 18–0. 20	5. 6–6. 0	Moderate or high	High.
100	90–100	70–80	0. 2–0. 63	0. 17–0. 19	7. 4–8. 4	Moderate	Moderate.
100	90–100	70–90	0. 63–2. 0	0. 17–0. 19	5. 6–6. 5	Moderate or hgih	Low.
100	95–100	90–95	0. 06–0. 24	0. 18–0. 20	5. 6–6. 0	Moderate or high	High.
100	90–100	70–80	0. 2–0. 63	0. 17–0. 19	7. 4–7. 8	Moderate	Moderate.
35–45	20–30	5–12	6. 3–20. 0	0. 03–0. 05	7. 4–8. 4	Low	Very low.
100	95–100	85–95	0. 2–0. 63	0. 18–0. 20	6. 1–6. 5	Moderate or high	Moderate or high.
100	95–100	90–95	0. 06–0. 2	0. 18–0. 20	5. 6–6. 0	Moderate or high	High.
100	90–100	70–80	0. 2–0. 63	0. 17–0. 19	7. 4–8. 4	Moderate	Moderate.
100	90–100	70–90	0. 63–2. 0	0. 17–0. 19	6. 0–7. 3	Moderate or high	Low.
100	85–100	65–80	0. 63–2. 0	0. 18–0. 20	5. 0–7. 3	Moderate	Moderate.
35–45	20–30	5–12	6. 3–20. 0	0. 03–0. 05	7. 4–8. 4	Low	Low.
100	95–100	85–95	0. 2–0. 63	0. 18–0. 20	6. 6–7. 3	Moderate or high	Moderate.
100	95–100	90–95	0. 06–0. 2	0. 18–0. 21	6. 6–7. 3	Moderate or high	High.
100	90–100	70–90	0. 06–0. 63	0. 17–0. 19	7. 4–8. 4	Moderate	Moderate.
100	95–100	85–95	0. 2–0. 63	0. 18–0. 20	6. 6–7. 3	Moderate	Moderate.
100	95–100	85–95	0. 06–0. 2	0. 18–0. 20	6. 6–7. 3	Moderate or high	High.
100	90–100	70–95	0. 06–0. 63	0. 18–0. 20	7. 4–8. 4	Moderate	Moderate.
100	95–100	85–95	0. 2–0. 63	0. 18–0. 20	6. 6–7. 3	Moderate	Moderate.
100	90–100	70–90	0. 06–0. 20	0. 18–0. 20	6. 6–7. 3	Moderate	Moderate.
100	50–90	15–35	2. 0–6. 3	0. 14–0. 17	7. 4–8. 4	Low	Low.

TABLE 6.—*Estimated engineering*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface (representative profile)	Classification		
			Dominant USDA texture	Unified	AASHO
	Feet	*Inches*			
Ross:					
Ro	>5	0–30	Silt loam	ML or CL	A-4 or A-6
		30–60	Silt loam or loam	ML or CL	A-4 or A-6
Sebewa:					
Se	[2] 0–3	0–11	Silty clay loam	CL or CH	A-6 or A-7
		11–33	Clay loam or silty clay loam	CL or CH	A-6 or A-7
		33–60	Stratified gravel and sand	GP	A-1
Shoals:					
Sh	1–3	0–12	Silt loam	ML	A-4
		12–30	Silt loam	ML	A-4
		30–60	Silty clay loam, clay loam, or loam	CL	A-4 or A-6
Sloan:					
Sn	[2] 0–3	0–13	Silt loam	ML or CL	A-4 or A-6
		13–26	Clay loam	CL or SC	A-6 or A-7
		26–60	Silt loam, loam, or loamy sand	ML, CL, or SM	A-2 or A-4
Wallkill:					
Wa	[2] 0–2	0–17	Silt loam	ML or CL	A-4 or A-6
		17–60	Muck and Peat	Pt	

[4] Water table is perched.

properties of the soils—Continued

Percentage passing sieve—			Permeability	Available moisture capacity	Reaction	Frost-heave potential	Shrink-swell potential
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)					
			Inches per hour	*Inches per inch of soil*	*pH value*		
100	90–100	70–90	0. 63–2. 0	0. 17–0. 19	7. 4–8. 4	Moderate	Low.
100	85–100	60–90	0. 63–2. 0	0. 17–0. 19	7. 4–8. 4	Moderate	Low.
100	95–100	85–95	0. 63–2. 0	0. 18–0. 20	6. 6–7. 3	Moderate	Low or moderate.
90–100	70–80	35–55	0. 63–2. 0	0. 18–0. 20	6. 6–7. 3	Moderate	Moderate.
25–35	5–10	0–5	6. 3–20. 0	0. 03–0. 05	7. 4–8. 4	Low	Very low.
100	90–100	70–90	0. 63–2. 0	0. 17–0. 19	6. 6–7. 3	Moderate or high	Low.
100	90–100	70–90	0. 63–2. 0	0. 17–0. 19	6. 6–7. 8	Moderate or high	Low.
100	85–100	60–80	0. 63–2. 0	0. 17–0. 19	7. 4–8. 4	Moderate	Moderate.
100	90–100	70–90	0. 63–2. 0	0. 17–0. 19	7. 4–7. 8	Moderate	Low.
90–100	70–80	35–55	0. 2–0. 63	0. 18–0. 20	7. 4–8. 4	Moderate	Moderate.
100	50–85	15–75	2. 0–20. 0	0. 14–0. 18	7. 4–8. 4	Low	Low.
100	90–100	70–90	0. 63–2. 0	0. 17–0. 19	6. 6–7. 3	Moderate	Low.
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[2] Ponded.

TABLE 7.—*Engineering*

[Not included in this table, because their characteristics are too variable to be classified,

Soil series and map symbols	Suitability as a source of— Topsoil	Sand and gravel	Road fill	Soil features affecting— Highway location	Reservoir area
Blount: BIA, BIB, BIB2	Good to a depth of 9 inches; poor below; clayey.	Not suitable	Poor in subsoil: high shrink-swell potential; highly plastic. Fair to poor in substratum: moderate shrink-swell potential; seasonal high perched water table.	Seasonal high perched water table; subject to frost heaving; plastic clay below the surface layer.	Slow seepage; seasonal high perched water table; clayey subsoil and substratum.
Brookston: Br	Fair or good to a depth of 12 inches; poor below; moderately fine textured.	Not suitable	Fair to poor in subsoil and substratum: moderate to low shrink-swell potential; subject to frost heaving; seasonal high water table.	Seasonal high water table; subject to frost heaving; moderately fine textured subsoil.	Seasonal high water table; slow seepage; moderately fine textured subsoil.
Bs	Fair to a depth of 12 inches; poor below; moderately fine textured; cobblestones on surface and in subsoil.	Not suitable	Poor in subsoil: cobblestones and boulders; seasonal high water table. Fair in substratum: low shrink-swell potential.	Seasonal high water table; subject to frost heaving; cobblestones and boulders in subsoil.	Seasonal high water table; slow seepage; cobblestones and boulders in subsoil.
Carlisle: Ca	Poor: organic material subsides rapidly; erodible.	Not suitable	Not suitable: organic; unstable; high water table.	Not suitable: unstable; high water table; subject to flooding.	High water table; organic material susceptible to flotation and cave-in.
Crosby: CrA	Good to a depth of 10 inches; poor below; moderately fine textured.	Not suitable	Poor in subsoil: moderate shrink-swell potential; moderately fine textured; seasonal high perched water table. Fair in substratum.	Seasonal high perched water table; subject to frost heaving; moderately fine textured subsoil.	Seasonal high perched water table; slow permeability; slow seepage; moderately fine textured subsoil.
CsA	Fair to a depth of 10 inches; poor below; cobblestones on surface and in subsoil.	Not suitable	Poor to fair in subsoil: moderate shrink-swell potential; cobblestones and boulders; seasonal high perched water table. Fair to good in substratum.	Seasonal high perched water table; cobblestones and boulders in subsoil; subject to frost heaving.	Seasonal high perched water table; cobblestones and boulders in subsoil.

interpretations of the soils

are the land types Borrow pits (Bp), Gravel pits and Stone quarries (Gp), and Made land (Ma)]

Soil features affecting—Continued					Limitations for sewage disposal	
Embankment	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Clayey; medium to high compressibility; moderate to high shrink-swell potential.	Slow permeability; seasonal high perched water table.	Dense clayey subsoil; difficult to establish vegetation.	Dense clayey subsoil; highly erodible; gently sloping.	Shrink-swell potential high in subsoil and moderate below a depth of 3 feet; seasonal high perched water table; slow permeability.	Severe: seasonal high perched water table; slow permeability.	Slight.
Moderately fine textured; medium to high compressibility; moderate to low shrink-swell potential.	Seasonal high water table; slow permeability.	Nearly level and in depressions; runoff very slow to ponded.	Features generally favorable.	Shrink-swell potential moderate in subsoil and low below a depth of 4 feet; seasonal high water table.	Severe: seasonal high water table; subject to ponding; slow permeability.	Slight.
Cobblestones and boulders in subsoil; low to medium compressibility in substratum.	Seasonal high water table; slow permeability; cobblestones and boulders on surface and in subsoil.	Nearly level; wetness; cobblestones and boulders in subsoil.	Cobblestones and boulders in subsoil.	Shrink-swell potential moderate in subsoil and low below a depth of 3½ feet; seasonal high water table.	Severe: seasonal high water table; subject to ponding; slow permeability.	Moderate or severe: stones in subsoil and substratum.
Organic; unstable; highly compressible.	Organic material subject to subsidence; poor outlets; high water table.	Nearly level and in depressions; wetness.	Runoff very slow; ponded in places; low in available phosphorus and potassium.	Unstable; organic; high water table.	Severe: high water table; nearly level and in depressions.	Severe: high content of organic matter; nearly level and in depressions; frequently ponded; drainage from higher areas.
Slow permeability; moderately fine textured subsoil; fair stability and compaction.	Slow permeability; seasonal high perched water table.	Features generally are favorable.	Dense moderately fine textured subsoil; moderately erodible.	Shrink-swell potential moderate in subsoil and low below a depth of 3 feet; seasonal high perched water table.	Severe: seasonal high perched water table; slow permeability.	Slight.
Slow permeability; cobblestones and boulders in subsoil; low compressibility.	Cobblestones and boulders in subsoil; seasonal high perched water table; slow permeability.	Cobblestones and boulders in subsoil.	Cobblestones and boulders in subsoil.	Shrink-swell potential moderate in subsoil and low below a depth of 3 feet; seasonal high perched water table.	Severe: slow permeability; seasonal high perched water table.	Moderate or severe: stones in subsoil and substratum.

TABLE 7.—*Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—	
	Topsoil	Sand and gravel	Road fill	Highway location	Reservoir area
Fox: FoC2, FoD2, FsA, FsB	Good to a depth of 9 inches; poor below; gravelly; moderately fine textured.	Good below a depth of 20 to 40 inches.	Fair to a depth of 20 to 40 inches; good below.	Well drained; loose gravel and sand in substratum; easily excavated; cuts and fills needed in many places; exposed road cuts difficult to vegetate.	Rapid seepage; substratum highly porous.
FxB3, FxC3	Poor in surface layer and subsoil; moderately fine textured; gravelly.	Good below a depth of 20 to 40 inches.	Fair to a depth of 20 to 40 inches; good below.	Well drained; loose gravel and sand in substratum; easily excavated; cuts and fills needed in many places; exposed road cuts difficult to vegetate.	Rapid seepage; substratum highly porous.
Genesee: Ge	Good to a depth of 36 inches.	Not suitable	Fair: subject to flooding.	Subject to flooding; subject to frost heaving.	Subject to flooding; moderate seepage.
Hennepin: HeE	Fair to a depth of 6 inches; steep; poor in subsoil.	Not suitable	Fair to poor: difficult to work and compact if wet; highly erodible.	Cuts and fills are needed; difficult to vegetate road cuts; very erodible.	Not suitable: steep
Kokomo: Km	Fair to good to a depth of 10 inches; poor in subsoil; clayey and gravelly.	Not suitable	Poor in subsoil: clayey and plastic. Fair in substratum: high water table.	High water table; subject to frost heaving; clayey subsoil; subject to ponding.	High water table; slow seepage; clayey subsoil.
Ko	Fair to a depth of 16 inches; poor below; clayey; high water table.	Not suitable	Poor in subsoil: clayey and plastic. Fair in substratum: high water table.	High water table; subject to frost heaving; clayey subsoil; subject to ponding.	High water table; slow seepage; clayey subsoil.

interpretations of the soils—Continued

Soil features affecting—Continued					Limitations for sewage disposal	
Embankment	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Fair to good stability and compaction in subsoil; good stability and compaction in substratum; rapid permeability.	Generally well drained; strong short slopes in places; hazard of erosion; droughty.	Sand and gravel at a depth of 20 to 40 inches.	Sand and gravel at a depth of 20 to 40 inches.	Low compressibility; loose gravel and sand below a depth of 20 to 40 inches.	Slight on slopes of not more than 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes of more than 12 percent; possible pollution of shallow wells by effluent.	Severe: loose porous gravel and sand at a depth of 20 to 40 inches.
Fair to good stability and compaction in subsoil; good stability and compaction in substratum; rapid permeability.	Well drained; short uneven slopes; hazard of erosion; droughty.	Sand and gravel at a depth of 20 to 40 inches.	Sand and gravel at a depth of 20 to 40 inches.	Low compressibility; loose gravel and sand below a depth of 20 to 40 inches.	Slight on slopes of not more than 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes of more than 12 percent; possible pollution of shallow wells by effluent.	Severe: loose porous gravel and sand at a depth of 20 to 40 inches.
Moderate permeability; fair stability; fair compaction.	Soil features generally favorable; subject to flooding; nearly level.	On nearly level flood plains; runoff is slow.	Nearly level	On flood plains and subject to flooding.	Severe: subject to flooding.	Severe: moderate permeability; subject to flooding.
Fair stability and compaction; medium compressibility.	Well drained	Short, steep slopes; highly erodible.	Steep slopes; difficult to vegetate; highly erodible.	Steep slopes	Severe on slopes of more than 18 percent.	Severe on slopes of more than 18 percent.
Fair stability, fair to good compaction, and slight to medium compressibility in subsoil; fair stability, fair compaction, and medium compressibility in substratum.	High water table; slow permeability; in depressions; poor outlets.	Nearly level and in depressions.	Nearly level and in depressions; very poorly drained; low in phosphorus and potassium.	Slight to medium compressibility and moderate or high shrink-swell potential in subsoil; high water table.	Severe: high water table; subject to ponding; slow permeability.	Severe: subject to ponding; drainage from higher areas.
Fair stability, fair to good compaction, slow permeability, and slight to medium compressibility in subsoil. Fair stability, fair compaction, and medium compressibility in substratum; contains stratified sand, silt, and some gravel.	High water table; slow permeability; in depressions; poor outlets.	Nearly level and in depressions.	Nearly level and in depressions; clayey subsoil; wetness.	Medium compressibility; moderate or high shrink-swell potential in subsoil; high water table.	Severe: high water table; subject to ponding; slow permeability.	Severe: subject to ponding.

TABLE 7.—*Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—	
	Topsoil	Sand and gravel	Road fill	Highway location	Reservoir area
Linwood: Lm	Poor: organic material subsides rapidly; erodible.	Not suitable	Poor in organic material: unstable; high water table. Fair to poor below organic layer.	Organic material to a depth of 12 to 40 inches; high water table; subject to frost heaving; low relief; subject to ponding.	Organic material to a depth of 12 to 40 inches; high water table; slow seepage in substratum;
Martinsville: MdC2	Fair to a depth of 11 inches; fair to poor below; moderately fine textured; sand content increases with depth.	Not suitable	Good in subsoil; fair to good in substratum.	Cuts and fills needed.	Moderate seepage; stratified sand and silt in substratum.
MeA, MeB	Good to a depth of 10 inches; fair to poor below; moderately fine textured; sand content increases with depth.	Not suitable	Good in subsoil; fair to good in substratum.	Cuts and fills needed.	Moderate seepage; stratified sand and silt in substratum.
Miami: MmA, MmB2, MmC2, MmD.	Good to a depth of 8 inches; poor below.	Not suitable	Poor in subsoil: moderately fine textured; plastic. Fair to poor in substratum: low shrink-swell potential; difficult to work and compact if wet.	Cuts and fills needed; subject to frost heaving; moderately fine textured subsoil.	Moderate to slow seepage; moderately fine textured subsoil.
MnA, MnB, MnC2	Good to a depth of 8 inches; poor below.	Good below a depth of 4 to 10 feet.	Poor in subsoil: plastic; moderately fine textured. Good in substratum.	Cuts and fills needed; subject to frost heaving; moderately fine textured subsoil; loose gravel and sand at a depth of 4 to 10 feet.	Rapid seepage in stratified sand and gravel.
MoA, MoB	Good to a depth of 8 inches; poor below.	Not suitable	Poor in subsoil: plastic; moderately fine textured. Poor in substratum: moderate shrink-swell potential; difficult to work and compact if wet.	Cuts and fills needed; subject to frost heaving; plastic; moderately fine textured below a depth of 3 feet.	Moderate to slow seepage.

nterpretations of the soils—Continued

Soil features affecting—Continued					Limitations for sewage disposal	
Embankment	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Unstable organic material to a depth of 12 to 40 inches; fair stability, fair compaction, and medium compressibility in substratum.	Organic material subject to subsidence; high water table; poor outlets.	In depressions; runoff very slow; ponded in places; organic material.	Very poorly drained; wetness; low in phosphorus and potassium.	Unstable organic material to a depth of 12 to 40 inches; high water table.	Severe: high water table; subject to ponding.	Severe: organic material.
Fair to good stability and compaction and medium compressibility in subsoil and substratum.	Well drained	Most features favorable, depending on slope.	All features favorable.	Deep; permeable; moderate to low shrink-swell potential.	Slight: possible pollution of shallow wells by effluent.	Severe: stratified sand and silt in substratum.
Fair to good stability and compaction and medium compressibility in subsoil and substratum.	Well drained	Most features favorable, depending on slope.	All features favorable.	Deep; permeable; moderate to low shrink-swell potential.	Slight: possible pollution of shallow wells by effluent.	Severe: stratified sand and silt in substratum.
Fair stability and compaction; moderately fine textured subsoil.	Well drained	All features favorable, if slopes are uniform.	Highly erodible on slopes of more than 6 percent; no limitations on lesser slopes; high runoff.	Shrink-swell potential moderate in subsoil and low at a depth of 2 to 3 feet.	Moderate on slopes of not more than 12 percent; severe on slopes of more than 12 percent; moderate permeability.	Slight on slopes of not more than 2 percent; moderate on slopes of 2 to 6 percent; severe on slopes of more than 6 percent.
Fair stability and compaction; moderately fine textured subsoil.	Well drained	Most features favorable, if slopes are uniform.	Features generally favorable on slopes of 6 percent or less; highly erodible on slopes of more than 6 percent; high runoff.	Shrink-swell potential moderate in subsoil and low to very low in substratum.	Moderate on slopes of not more than 12 percent; moderate permeability. Severe on slopes of more than 12 percent; possible pollution of shallow wells by effluent.	Severe: loose, porous gravel and sand at a depth of 4 to 10 feet.
Fair stability and compaction; medium to high compressibility.	Well drained	Most features favorable, if slopes are uniform.	Features generally favorable.	Shrink-swell potential moderate in subsoil and substratum.	Moderate: moderate permeability.	Slight on slopes of not more than 2 percent; moderate on slopes of 2 to 6 percent.

TABLE 7.—*Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—	
	Topsoil	Sand and gravel	Road fill	Highway location	Reservoir area
Miami—Continued MrB3, MrC3	Poor in surface layer and subsoil; moderately fine textured.	Not suitable	Poor in subsoil: plastic; moderately fine textured. Fair to poor in substratum: moderate shrink-swell potential; difficult to work and compact if wet.	Cuts and fills needed; subject to frost heaving; moderately fine textured subsoil.	Moderate to slow seepage.
Morley: MuB, MuB2, MuD2	Fair to good to a depth of 8 inches; poor below; clayey.	Not suitable	Poor in subsoil and substratum: moderate to high shrink-swell potential; plastic clay; difficult to work; compact if wet.	Cuts and fills needed; subject to frost heaving; plastic clay.	Slow seepage; clayey subsoil and substratum.
MvB2, MvC2	Fair to good to a depth of 8 inches; poor below; clayey.	Good below a depth of 4 to 10 feet.	Poor in subsoil: moderate to high shrink-swell potential; plastic clay. Good in substratum.	Cuts and fills needed; subject to frost heaving; plastic clay; erodes readily.	Slow seepage in clayey subsoil; porous loose gravel and sand below a depth of 4 to 10 feet.
MwB3, MwC3	Poor in surface layer and in subsoil; clayey.	Not suitable	Poor in subsoil and substratum: moderate to high shrink-swell potential; plastic clay.	Cuts and fills needed; plastic clay.	Slow seepage; clayey.
Ockley: OcA, OcB	Good to a depth of 10 inches; poor below; moderately fine textured; gravelly.	Good below a depth of 42 inches.	Fair to a depth of 42 inches and good below.	Well drained; stratified gravel and sand below a depth of 42 inches; easily excavated.	Rapid seepage in substratum.

interpretations of the soils—Continued

Soil features affecting—Continued					Limitations for sewage disposal	
Embankment	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Fair stability and compaction; medium to high compressibility.	Well drained	Most features favorable, if slopes are uniform.	Features generally favorable.	Shrink-swell potential moderate in subsoil and low in substratum.	Moderate on slopes of 2 to 12 percent; severe on slopes of more than 12 percent; moderately slow to moderate permeability.	Moderate on slopes of 2 to 6 percent; severe on slopes of more than 6 percent.
Fair stability and compaction; slow permeability; medium to high compressibility; clayey subsoil.	Well drained	Most features favorable, if slopes are uniform.	Denso clayey subsoil; difficult to vegetate.	Shrink-swell potential high in subsoil and moderate below a depth of 2½ feet; slow permeability.	Severe: slow permeability.	Moderate on slopes of 2 to 6 percent; severe on slopes of more than 6 percent.
Fair stability and compaction; slow permeability; moderate to high shrink-swell potential; medium to high compressibility; clayey subsoil; loose gravel and sand below a depth of 4 to 10 feet.	Well drained	Most features favorable, if slopes are uniform.	Clayey subsoil; difficult to vegetate.	High shrink-swell potential in subsoil.	Severe: slow permeability.	Severe: loose porous gravel and sand below a depth of 4 to 10 feet; slopes of more than 6 percent.
Fair stability and compaction; slow permeability; moderate to high shrink-swell potential; medium to high compressibility; clayey subsoil.	Well drained	Most features favorable, if slopes are uniform; difficult to vegetate.	Dense clayey surface layer and subsoil; difficult to vegetate.	Shrink-swell potential high in subsoil and moderate below a depth of 2 feet.	Severe: slow permeability.	Moderate on slopes of 2 to 6 percent; severe on slopes of more than 6 percent.
Fair stability, fair compaction, and slight to medium compressibility in subsoil; loose gravel and sand, good compaction, fair to poor stability, and slight compressibility in substratum.	Well drained	Most features favorable, if slopes are uniform.	Features generally favorable.	Deep; moderate permeability; moderate shrink-swell potential in subsoil; loose gravel and sand below a depth of 42 inches.	Slight: possible pollution of shallow wells by effluent.	Severe: gravelly in lower subsoil; porous loose gravel and sand at a depth of 42 inches.

TABLE 7.—*Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—	
	Topsoil	Sand and gravel	Road fill	Highway location	Reservoir area
Pewamo:					
Pe	Fair to a depth of 12 inches; poor below; clayey.	Not suitable	Poor in subsoil and substratum: difficult to compact; moderate to high shrink-swell potential; subject to frost heaving; seasonal high water table.	Seasonal high water table; subject to frost heaving; clayey below surface layer.	Seasonal high water table; slow seepage; clayey below surface layer.
Pf	Fair to a depth of 12 inches; poor below; clayey.	Not suitable	Poor in subsoil and substratum: moderate to high shrink-swell potential; plastic clay difficult to compact; seasonal high water table.	Seasonal high water table; plastic clay; clayey subsoil.	Slow seepage; clayey subsoil; seasonal high water table.
Pk (For interpretations of Brookston soils in mapping unit Pk, see Brookston series in this table.)	Good to a depth of 10 to 20 inches; poor below; clayey.	Not suitable	Poor in subsoil and substratum: moderate to high shrink-swell potential; subject to frost heaving; plastic clay; seasonal high water table.	Seasonal high water table; subject to frost heaving; clayey below surface layer; subject to ponding.	Seasonal high water table; slow seepage; clayey subsoil.
Rensselaer:					
Rc	Fair or good to a depth of 12 inches; poor below; moderately fine textured.	Not suitable	Fair to poor in subsoil: plastic; moderately fine textured. Fair in substratum: silt and stratified sand; seasonal high water table.	Seasonal high water table; subject to frost heaving; moderately fine textured subsoil.	Seasonal high water table; moderate to slow seepage; moderately fine textured subsoil.
Ross:					
Ro	Good to a depth of 36 inches.	Not suitable	Fair: low shrink-swell potential; medium compressibility; fair stability.	Subject to flooding; subject to frost heaving.	Subject to flooding; moderate to slow seepage.
Sebewa:					
Se	Fair or good to a depth of 11 inches; poor below; moderately fine textured; gravelly.	Good below a depth of 24 to 40 inches.	Fair to poor in subsoil: low or moderate shrink-swell potential; seasonal high water table. Good in substratum: stratified gravel and sand.	Seasonal high water table; subject to frost heaving; loose gravel and sand at a depth of 24 to 40 inches.	Seasonal high water table; rapid seepage in substratum.
Shoals:					
Sh	Good to a depth of 12 inches; good to poor below; variable stratified layers.	Not suitable	Fair: seasonal high water table; difficult to work and compact if wet.	Subject to flooding; seasonal high water table; subject to frost heaving.	Seasonal high water table; subject to flooding; slow seepage.

interpretations of the soils—Continued

Soil features affecting—Continued					Limitations for sewage disposal	
Embankment	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Fair stability and compaction; slow permeability; medium to high compressibility; clayey subsoil.	Seasonal high water table; slow permeability.	Nearly level and in depressions.	Very poorly drained; wetness; low in phosphorus and potassium.	Shrink-swell potential high in subsoil and moderate below a depth of 4 feet; seasonal high water table; slow permeability.	Severe: seasonal high water table; subject to ponding; slow permeability.	Slight: slow permeability; high clay content.
Fair stability; slow permeability; clayey subsoil; medium to high compressibility.	Seasonal high water table; slow permeability.	Nearly level and in depressions.	Very poorly drained; wetness; low in phosphorus and potassium.	Compressibility and shrink-swell potential high in subsoil and moderate below a depth of 4 feet; seasonal high water table.	Severe: slow permeability; seasonal high water table.	Slight: slow permeability; high clay content.
Fair stability and compaction; slow permeability; medium to high compressibility; clayey subsoil.	Seasonal high water table; slow permeability; poor outlets; subject to ponding.	Nearly level and in depressions.	Subject to ponding; wetness.	Shrink-swell potential moderate to high in subsoil and moderate below a depth of 4 feet; seasonal high water table; slow permeability; subject to ponding.	Severe: seasonal high water table; slow permeability; subject to ponding.	Slight.
Fair stability, fair to good compaction, medium compressibility, and slow permeability in subsoil; fair stability, fair compaction, and medium compressibility in substratum.	Seasonal high water table; slow permeability.	Nearly level and in depressions.	Runoff slow; ponded in places; low in phosphorus and potassium.	Shrink-swell potential moderate in subsoil and low below a depth of 3½ feet; seasonal high water table.	Severe: seasonal high water table; subject to ponding; slow permeability.	Slight.
Moderate permeability; fair stability; fair compaction; subject to flooding.	Well drained	Nearly level; on flood plains.	Nearly level; on flood plains.	On flood plains and subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.
Fair stability and fair to good compaction in subsoil; good stability and compaction in substratum; contains loose gravel and sand.	Seasonal high water table; sand and gravel below a depth of 24 to 40 inches.	Nearly level and in depressions.	Very poorly drained; wetness.	Shrink-swell potential moderate in subsoil and low at a depth of 24 to 40 inches; seasonal high water table.	Severe: seasonal high water table; possible stream pollution through loose gravel and sand.	Severe: gravelly in lower subsoil; loose gravel and sand at a depth of 24 to 40 inches.
Fair stability and compaction; subject to flooding; medium compressibility.	Seasonal high water table; subject to flooding.	Nearly level; on flood plains.	Somewhat poorly drained; wetness.	Seasonal high water table; on flood plains and subject to flooding.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding.

TABLE 7.—*Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—	
	Topsoil	Sand and gravel	Road fill	Highway location	Reservoir area
Sloan:					
Sn	Fair or good to a depth of 12 inches; poor below; variable stratified layers; gravelly.	Not suitable	Fair to poor: subject to frost heaving and flooding; seasonal high water table.	Subject to flooding; seasonal high water table; subject to frost heaving.	Seasonal high water table; subject to flooding; slow seepage.
Wallkill:					
Wa	Good to a depth of 10 to 20 inches.	Not suitable	Not suitable	Organic material at a depth below 10 to 20 inches; unstable; subject to ponding.	Organic material; high water table.

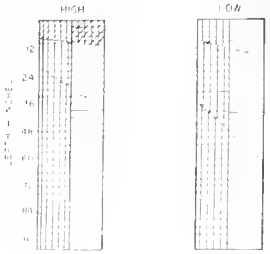
interpretations of the soils—Continued

Soil features affecting—Continued					Limitations for sewage disposal	
Embankment	Agricultural drainage	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Fair stability and compaction; subject to flooding; medium compressibility.	Seasonal high water table; subject to flooding.	Nearly level and in depressions; flood plains.	Runoff very slow; wetness.	Shrink-swell potential moderate in subsoil and low below a depth of 3 feet; subject to flooding and ponding; seasonal high water table; moderately slow permeability.	Severe: seasonal high water table; subject to flooding; moderately slow permeability.	Severe: subject to flooding.
Organic material at a depth below 10 to 20 inches; subject to ponding.	High water table; subject to ponding; poor outlets.	In depressions.	Level; very poorly drained.	Unstable organic material below a depth of 10 to 20 inches; high water table; subject to ponding.	Severe: high water table; subject to ponding; organic material below a depth of 10 to 20 inches.	Severe: high content of organic matter; low and frequently ponded; drainage from higher areas.

GENERAL SOIL PROFILES

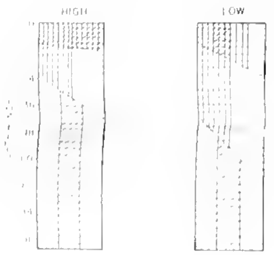
RIDGE AND GROUND MORAINE

CLAYEY TEXTURE
(PROFILE SET NO 1)



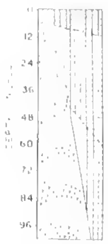
RIDGE AND GROUND MORAINE

CLAYEY TO SILTY TEXTURE
(PROFILE SET NO 2)



ESKERS AND KAMES

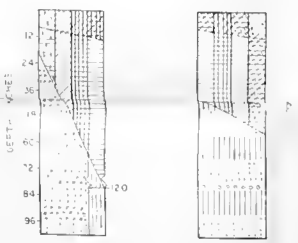
GRAVEL AND SAND TEXTURE
(PROFILE NO 3)



OUTWASH PLAINS

SAND AND GRAVEL (PROFILE NO 4)

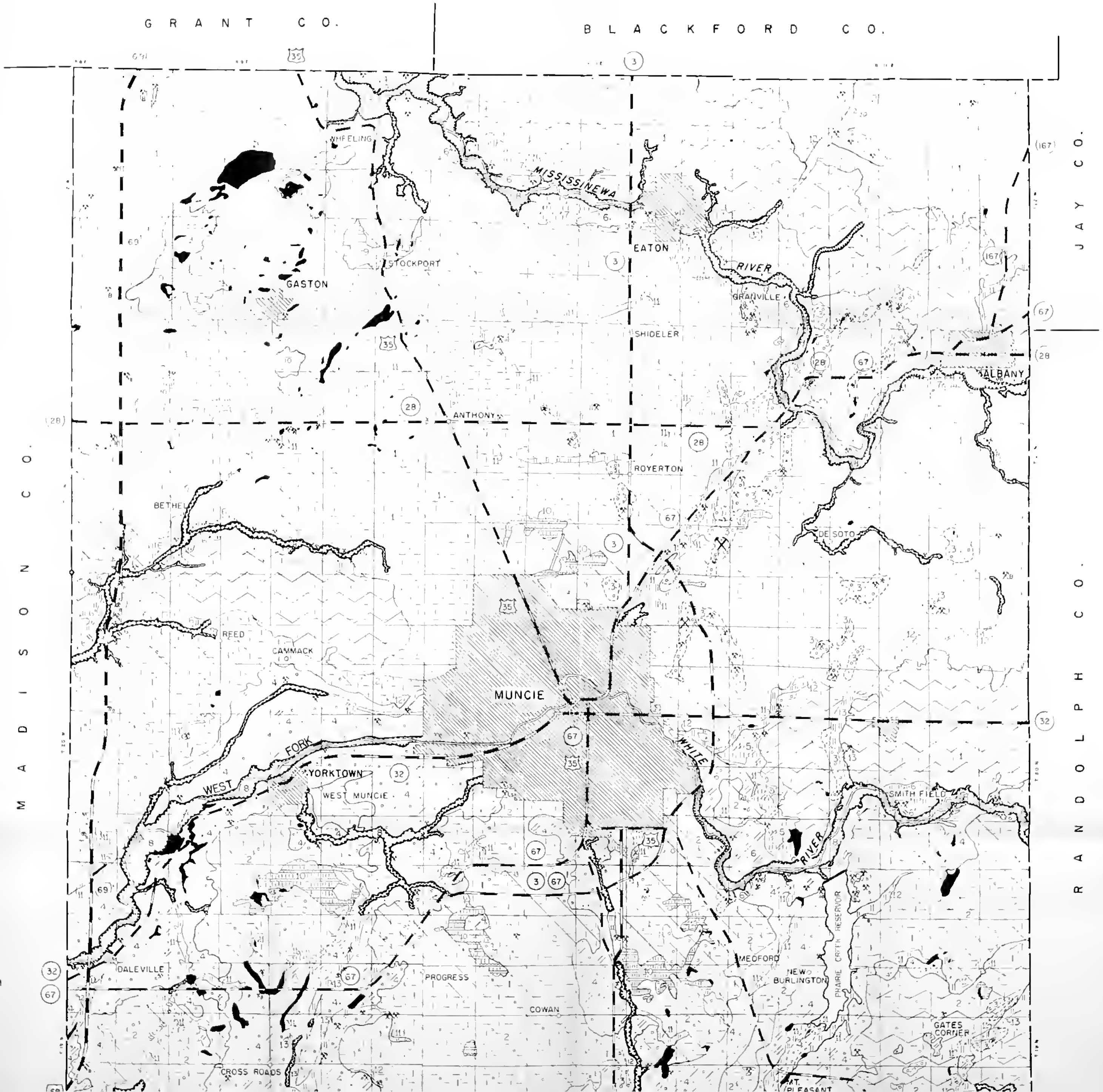
SAND AND SILT (PROFILE NO 5)



TERRACES AND VALLEY TRAINS

SAND AND GRAVEL (PROFILE NO 6)

GRAVELLY SILT LOAM (PROFILE NO. 7)



LEGEND

PARENT MATERIALS
(GROUPED ACCORDING TO LAND FORM AND ORIGIN)

- WISCONSIN RIDGE MORAINE
- WISCONSIN GROUND MORAINE
- ESKER OR KAME
- ALLUVIAL PLAIN
- VALLEY TRAIN (GLACIAL SLUICEWAYS)
- TERRACE
- OUTWASH PLAIN
- LACUSTRINE PLAIN
- PEAT AND MUCK

MISCELLANEOUS

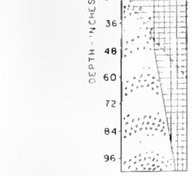
- GRAVEL PIT, B - BORROW PIT, LS - LIMESTONE QUARRY
- HIGHLY ORGANIC TOPSOIL

TEXTURAL SYMBOLS
(SUPERIMPOSED ON PARENT MATERIAL SYMBOLS TO SHOW RELATIVE COMPOSITION)

- GRAVEL
- SAND
- SILT
- CLAY

TEXTURAL SYMBOLS FOR SOIL PROFILES

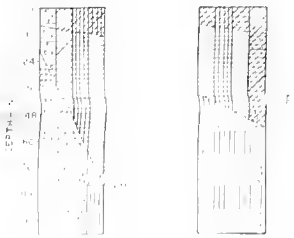
- GRAVEL
- SAND
- SILT
- CLAY
- LOAM



OUTWASH PLAINS

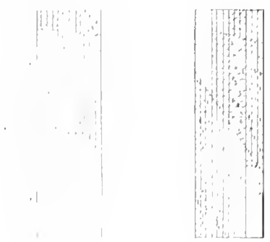
SAND AND GRAVEL (PROFILE NO 4)

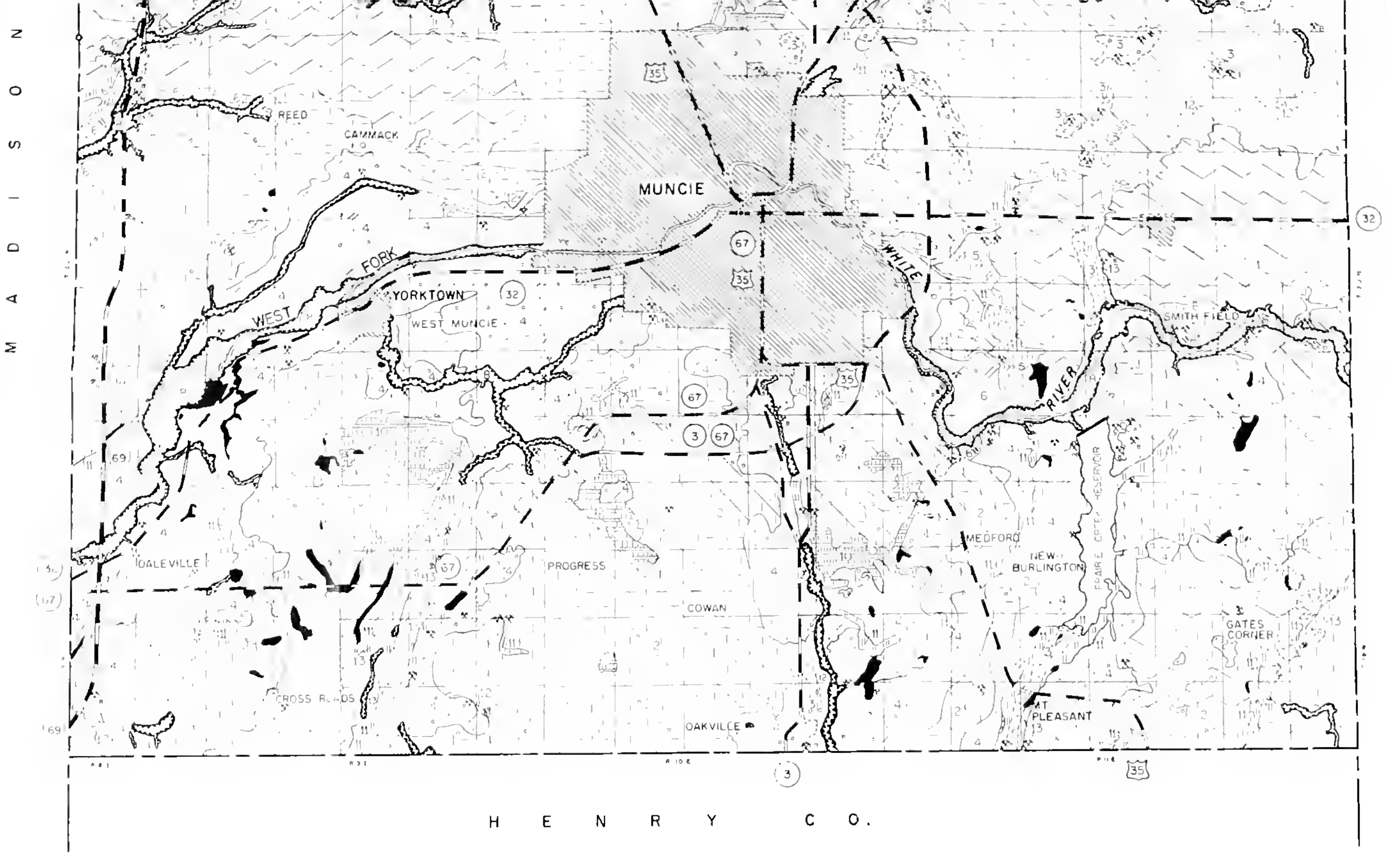
SAND AND SILT (PROFILE NO 5)



TERRACES AND VALLEY TRAINS

GRAVELLY SILT LOAM (PROFILE NO 7)

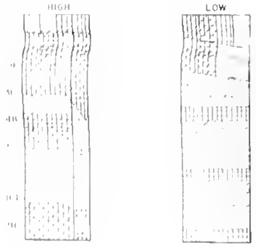




TEXTURAL SYMBOLS FOR SOIL PROFILES

ALLUVIAL PLAINS

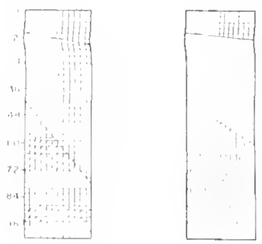
SILT AND SAND TEXTURE (PROFILE SET NO 8)



LACUSTRINE PLAINS

CLAYEY (PROFILE NO 9)

SILTY AND SANDY (PROFILE NO. 10)



ENGINEERING SOILS MAP

DELAWARE COUNTY

INDIANA

PREPARED FROM

1941 AAA AERIAL PHOTOGRAPHS

BY

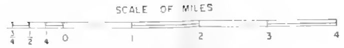
JOINT HIGHWAY RESEARCH PROJECT

AT

PURDUE UNIVERSITY

1969

SCALE OF MILES

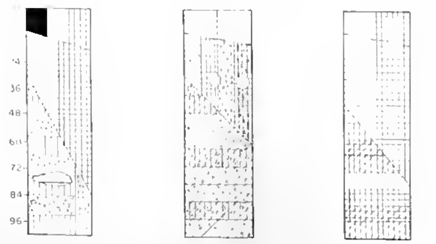


GLACIAL SLUICEWAYS – NARROW VALLEY TRAINS

SANDY AND SILTY (PROFILE NO 11)

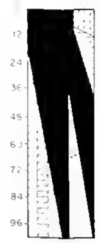
GRAVELLY SILT LOAM (PROFILE NO. 12)

CLAYEY (PROFILE NO 13)



PEAT AND MUCK

(PROFILE NO 14)



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